

OPTIONS for ENERGY EFFICIENCY in EXISTING BUILDINGS



COMMITTEE DRAFT REPORT

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Arnold Schwarzenegger
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DISCLAIMER

This report was prepared by the California Energy Commission's Energy Efficiency Committee in response to Assembly Bill 549. The report will be considered for adoption by the full Energy Commission at its Business Meeting on December 14, 2005. The views and recommendations contained in this document are not official policy of the Energy Commission until the report is adopted.

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EXECUTIVE SUMMARY

AB 549 (Longville), Chapter 905, Statutes of 2001, directs the California Energy Commission to "investigate options and develop a plan to decrease wasteful peak-load energy consumption in existing residential and nonresidential buildings" and report its findings to the legislature. The Energy Commission's initial response to this legislation was the report, *Assessing the Energy Savings Potential in California's Existing Buildings: An Interim Report to the Legislature in Response to AB 549* (December, 2003 Energy Commission Report #400-03-023F). The following Efficiency Committee draft report is based upon the interim work, research efforts conducted since that time, and public comment received at two workshops.

The passage of AB 549 was contemporaneous with urgency legislation passed in response to the 2000-2001 electricity crisis. That urgency legislation directed the Energy Commission and others to take a set of emergency actions, including aggressive updating of the Building and Appliance Energy Efficiency Standards and extensive retrofit actions in existing buildings to immediately advance energy efficiency. AB 549 recognized the need for additional actions that could be taken over the longer term.

California's long legacy of energy efficiency programs has exceeded the efforts of other states and many countries of the world. With the passage of the Warren-Alquist Act in 1975, California began the process of establishing, and vigorously updating, building and appliance standards. Building standards affect newly constructed buildings, additions and alterations to existing buildings, and the efficiency of appliances and equipment used in new and existing buildings. Significant ratepayer investments in utility-administered information and incentive programs accompanied the advancement of the Standards. Over the last 30 years, utility ratepayers have funded programs worth over \$5 billion, the majority of which has been spent to promote energy efficiency in existing buildings.

In the years since the electricity crisis, there have been two successive rounds of updates to the building and appliance standards. These updates have established new benchmarks for the rest of the U.S. They have been replicated by other states and have influenced the 2005 Federal Energy Policy Act. The Energy Commission and the utilities have also conducted emergency programs to reduce summer peak load through energy efficiency investments, demand response actions, and consumer behavioral and business operational changes. These actions in response to the electricity crisis have resulted in additional energy efficiency improvements in existing buildings.

New energy efficiency initiatives and programs have recently been launched in California, with the goal of improving the energy efficiency of existing buildings. These initiatives include first, the Green Building Initiative (GBI) that commits the state to a series of actions that will result in a 20 percent reduction in the energy use of state-owned buildings by 2015 and seeks a 20 percent increase in the stringency of building energy efficiency standards for nonresidential buildings. The GBI also calls for a 20

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percent reduction the energy use of privately-owned buildings. Second, the California Public Utilities Commission (CPUC), with the collaboration of the Energy Commission, recently adopted significantly expanded program goals and spending levels for the investor-owned utilities' efficiency programs. Third, California has made major commitments to reducing greenhouse gas emissions in the immediate, middle and longer term – energy efficiency will be an important contributor to the success of meeting those commitments.

The Efficiency Committee recommends that existing funding for energy efficiency programs be used to accomplish the strategies advocated within this report. Where the 2006-2008 utility program budgets do not assign sufficient priority to these strategies, we recommend that the utilities use the flexibility accorded under the CPUC decision to re-allocate the funds. Publicly-owned utilities which do not have access to the IOU's public good charge (PGC) funding, have their individual efficiency programs; the Energy Commission will continue to work with them and support their efforts to incorporate the programs outlined here.

The strategies recommended in this report reflect what the Efficiency Committee considers to be the most likely opportunities to effect a significant change in a building's energy-consuming characteristics. We focused on opportunities resulting from sale of the property, end of the useful life of equipment and components, new tenant improvements, refinancing, and major remodeling, renovation or rehabilitation. It is the Efficiency Committee's view that providing information about each specific building's energy efficiency potential would be most effective at those times. Strategies such as home energy ratings, benchmarking and retro-commissioning can be incorporated into the appropriate transactions.

In addition to actions taken at these key trigger points, we advocate that more attention be given to:

- maximizing the effectiveness of information regarding energy bills,
- mining utility bill information to encourage comparisons to similar households or businesses,
- monitoring of individual customer energy use and energy efficiency improvements to improve outreach methods, and
- developing information designs that motivate the customer to make energy efficiency improvements.

Utilities have made efforts in information delivery in the past and in some cases are proposing very similar advancements in their 2006-2008 programs – we applaud those efforts and advocate that they be aggressively pursued.

The Efficiency Committee concludes that the following strategies offer the most promise for further cost-effective energy and peak-load savings in existing buildings. These options are estimated to save from 493 to 767 GWh of electricity usage each year. Program costs of \$130 million to \$179 million annually would be primarily funded through allocation of existing energy efficiency program funds to these strategies.

Residential Strategies

Time-of-Sale Information Disclosure - The Efficiency Committee believes that ultimately there should be a statewide requirement for the disclosure of home energy ratings at the time-of-sale. Recognizing that there are some critical infrastructure needs before a mandatory program is practical, the Efficiency Committee recommends that a series of specific actions be initiated to move expeditiously in that direction.

Information Gateway - Information provided through a central clearinghouse, or gateway, should refer customers to applicable energy efficiency programs and services, to aid and motivate the homeowner to take action.

Whole Building Diagnostic Testing - Whole building diagnostic testing is a process to systematically detect flaws in building construction or operation, diagnose their causes, and facilitate, enable and verify their correction. This is a relatively expensive strategy. However, homeowners using whole building testing often find it worth the cost due to the non-energy benefits that are realized. Cost effectiveness analysis traditionally has expected the full cost of this strategy to be compensated by energy savings although consumers' willingness to pay for the service is also driven by their desire to achieve non-energy benefits.

Assistance to Affordable Housing - This strategy is intended to work within existing policies, procedures and agencies to improve the energy efficiency of these units. Key to the proposals are the financing opportunities that are available to the owners of affordable housing.

Equipment Tune-Ups - This strategy focuses on increasing the frequency and effectiveness of heating ventilation and air conditioning (HVAC) system tune-ups and maintenance services for single family and multi-family residential customers.

Commercial Strategies

Benchmarking - Energy consumption information can be provided in a form that customers, in this case commercial building owners and operators, can use to compare their building's performance compared to similar buildings. A California-specific benchmarking tool is being developed for the Green Building Action Team.

Retro-commissioning - Retro-commissioning systematically investigates the operation of a building's energy consuming equipment to detect, diagnose, and correct faults in commercial building systems operations.

In addition, the Efficiency Committee advocates continued and expanded implementation of **demand response strategies** for both residential and commercial customers. As AB 549 indicates, improved efficiency of energy use requires us to focus on customer use at the times of the utilities' peak demands as well as overall customer use. The investor-owned utilities are considering installing advance metering systems

for all their customers. These advanced systems will provide both load management capabilities and significantly improved customer usage information.

Legislative Actions

In order to capture the long term benefits of the strategies proposed in this report, specific legislative action is recommended:

- Require energy ratings and energy efficiency upgrades for properties that participate in subsidized housing tax credit programs. Allow the cost of energy ratings to be an eligible cost under the tax credit.
- Require benchmarking when commercial buildings are financed or refinanced.
- Require the California State Teachers Retirement System and Public Employees Retirement System to benchmark all buildings in their portfolio and pursue energy efficiency to improve those buildings to achieve at least a 20 percent savings improvement consistent with the Green Building Initiative.
- Require the Energy Commission to prepare a report on the experience and results of the Information at Time-of-Sale Disclosure program.

CHAPTER 1: Purpose and Structure of the Report

This report is in response to AB 549, which calls on the Energy Commission to investigate options to reduce wasteful peak load energy use in California's existing residential and nonresidential buildings. The attention on existing buildings, augments the impact of the Energy Commission's Building and Appliance Energy Efficiency Standards. Reducing energy consumption and peak demand through greater energy efficiency is the cornerstone of the state's energy policy. Homes and commercial buildings consume 66 percent of the state's electricity, improving the efficiency with which this energy is used will contribute significantly to the adequacy of the state's electricity supply.

There are over 13 million existing buildings in California, compared to the approximately 200,000 constructed each year. More than half of the existing buildings were built before the first energy efficiency standards were established in 1978. While many have been upgraded over time, these older buildings represent a large reserve of potential energy and peak demand savings.

We note that options for reducing peak consumption include those that increase the efficiency of buildings and equipment that use electricity during peak periods as well as those that shift or shave peak demand. Strategies that reduce natural gas end-use consumption are also included because they can help stabilize gas supplies and reduce price spikes in both electricity and gas markets since a large and growing portion of California's electricity generation is fueled by natural gas.

The remaining report chapters are as follows:

- Chapter 2. Current Programs and Initiatives
- Chapter 3. Energy Savings Potential of Existing Buildings
- Chapter 4. Recommended Residential Strategies
- Chapter 5. Recommended Commercial Strategies
- Chapter 6. Demand Response

CHAPTER 2: Current Programs and Initiatives

Building and Appliance Standards

Statewide Building Standards, which are adopted under Title 24, Part 6, of the California Code of Regulations, apply to both residential and nonresidential buildings. First put into effect in 1978, in response to the Warren-Alquist Act's mandate to reduce California's energy consumption, they are enforced by local building departments. The Building Standards are a critical tool for achieving California's energy efficiency goals.

In addition, the Energy Commission adopts Appliance Standards under Title 20. The Appliance Standards, which apply to a large number of appliances and equipment categories, prohibit the manufacture for sale in California of non-complying appliances. The first Appliance Standards went into effect in 1976. The Building Standards adopt the Appliance Standards by reference and, in some cases, set more stringent efficiency requirements for appliances that are permanently installed in newly constructed or existing buildings.

The Energy Commission stepped-up the intensity of both Building and Appliance Standards in response to the 2000-2001 energy crisis and subsequent energy policy direction. In 2000, Assembly Bill 970, directed the Energy Commission to adopt emergency updates to both Building Standards and Appliance Standards. In 2001, Senate Bill 5X required the Energy Commission to adopt energy efficiency standards for outdoor lighting, including lighting in unconditioned buildings, such as warehouses. As a result, the Building Standards were substantially updated in 2001 and 2003 and the Appliance Standards, in 2002 and 2004.

The recent standards' updating effort was targeted not only at raising the energy efficiency of newly constructed buildings, but also additions and alterations to existing buildings and the installation of equipment in existing buildings. This emphasis is partially in response to concerns, as raised in AB 549, about the need to achieve greater efficiency in existing buildings. An example of the new Building Standards emphasis is the requirement to test and seal ducts in existing buildings when central heating and air conditioning equipment is replaced.

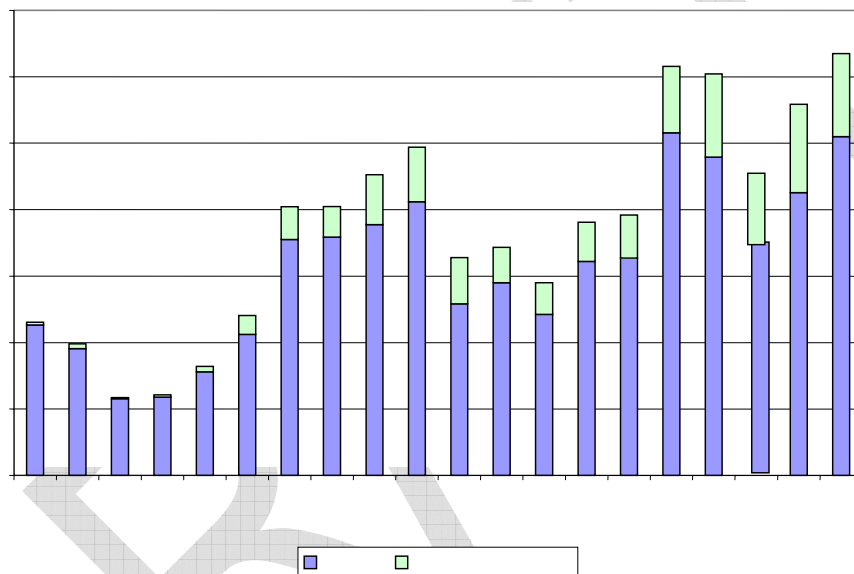
It is estimated that between 1975 and 2003, California's programs and Building and Appliance Standards have saved close to 40,000 gigawatt hours (GWh) of electricity and nearly 12,000 megawatts (MW) of peak demand, equivalent to more than two dozen 500 MW power plants.¹ The Standards have saved the equivalent of over \$56 billion in electricity and natural gas costs above the costs of compliance. The Energy Commission expects that the Standards will save an additional \$23 billion by 2013.

¹ Source: *Integrated Energy Policy Report Draft*, 2005.

Utility Energy Efficiency Programs

California utilities have a long history of investing in energy efficiency programs. Since 1976, they have spent over \$5.6 billion on reducing electricity and natural gas use in existing buildings, ranging from \$10 million to \$310 million per year. Figure 2-1 shows spending by the IOUs on energy efficiency programs for new and retrofit (existing) buildings since 1985. Most expenditures (84 percent) have been directed toward the existing buildings market.

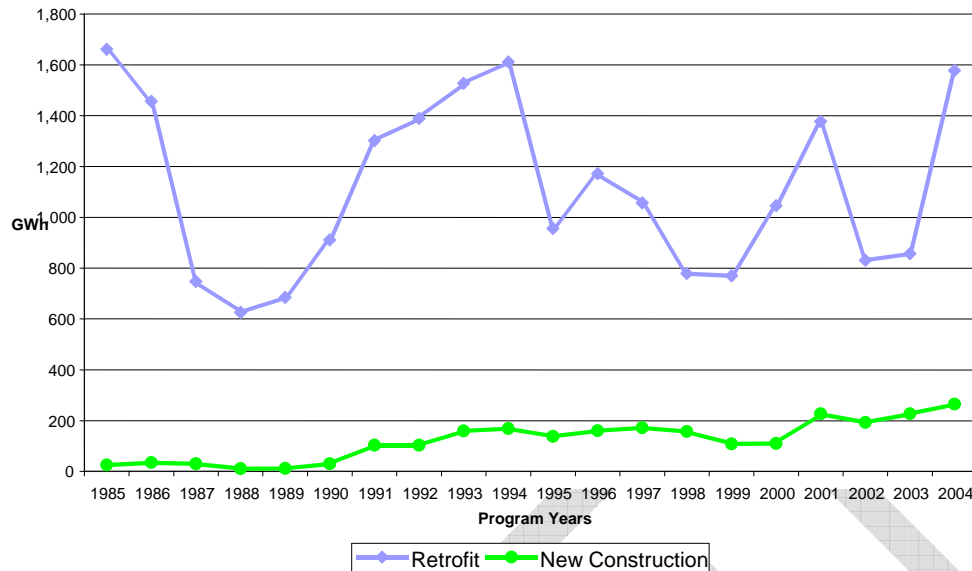
Figure 2-1



First year savings in GWh are shown in the Figure 2-2 for the same time period. With the exception of 1985, savings achieved are proportional to expenditures. Savings for existing buildings have ranged from 626 to 1,661 GWh hours per year.

Figure 2-2

First Year Savings for Retrofit and New Construction Sectors for PY 1985-2004



In the *2003 Energy Report* the Energy Commission recommended the following:

- Increase public funding for cost effective energy efficiency programs above then current levels to reduce peak electricity demand by at least an additional 1,700 MWs and reduce total electricity used by 6,000 GWh by 2008
- Increase funding for natural gas efficiency programs to reduce natural gas use an additional 100 million therms by 2013
- Standardize and increase the evaluation and monitoring of energy efficiency programs to ensure delivery of savings and benefits
- Implement appropriate mandates, incentives, and funding to maximize the energy efficiency potential of existing buildings.

The *2003 Energy Report* concluded that the maximum achievable cumulative savings from energy efficiency programs over the next decade would be 30,000 GWh. In September 2004, the CPUC adopted a set of aggressive energy savings goals designed to reach and exceed this potential. The Energy Commission has been an active partner with the CPUC and the investor-owned utilities in planning and administering these programs.

As shown in Table 2-1, the CPUC goals exceed the recommendations in the Energy Commission's *2003 Energy Report*. If these goals are met, the energy savings could represent as much as 59 percent of the investor-owned utilities' additional electricity needs between 2004 and 2013, and could increase natural gas savings by 116 percent over the next decade. Ensuring that savings from these efficiency programs are achieved is a vital component of the state's *Energy Action Plan*, and a top priority of both agencies.

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Table 2-1
Electricity and Natural Gas Program Savings Goals
(All Investor-Owned Utilities)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total Annual Electricity Savings (GWh/yr)	1,838	1,838	2,032	2,275	2,505	2,538	2,465	2,513	2,547	2,631
Total Cumulative Savings(GWh/yr)	1,838	3,677	5,709	7,984	10,489	13,027	15,492	18,005	20,552	23,183
Total Peak Savings (MW)	379	757	1,199	1,677	2,205	2,740	3,259	3,789	4,328	4,885
Total Annual Natural Gas Savings (MMTh/yr)	21	21	30	37	44	52	54	57	61	67
Total Cumulative Natural Gas Savings (MMTh/yr)	21	42	72	110	154	206	260	316	377	444

Source: CPUC Decision 04-09-060, September 23, 2004, *Interim Opinion: Energy Savings goals for Program Year 2006 and Beyond*.

On September 22, 2005, CPUC approved aggressive energy efficiency program plans filed by the investor-owned utilities for 2006 through 2008 (Table 2-2). These plans document the utilities' intent for carrying out programs in response to the goals that were previously adopted by the CPUC (Table 2-1). The programs are expected to provide greater energy savings than previously achieved by any set of utility programs in California, over 2,000 GWh per year. Peak demand savings are projected to be 1500 MW over the three years, with natural gas savings exceeding 47 million therms annually by 2008. The \$2 billion funding will come from a combination of the utilities' resource procurement budgets and PGC funds. Eighty five percent of the funds will be invested in electric efficiency programs with the balance going to natural gas programs.

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Table 2-2

Statewide Funding and Energy Savings Goals By Sector
Approved 2006 - 2008 Program Plan Filings

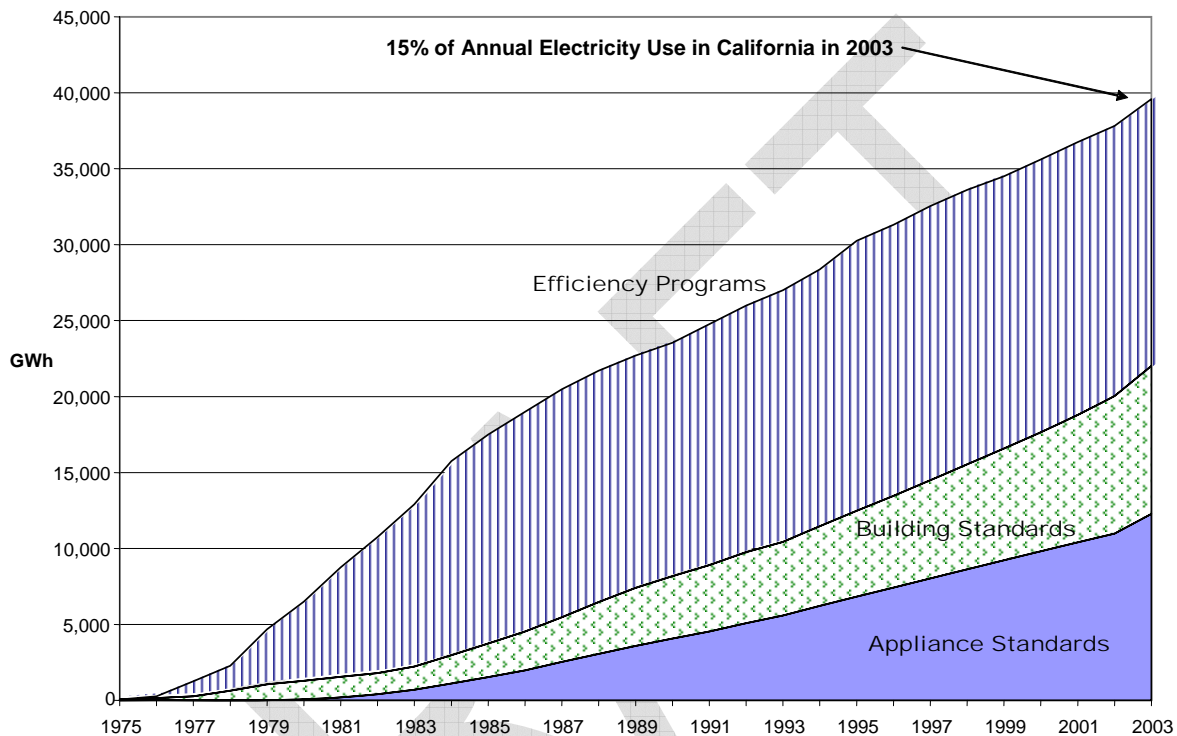
	Funding	% of Total	Savings (Net kWh)	% of Total	Savings (Net Therms)	% of Total
Existing Residential	\$464,762,202	21.8	2,056,228,241	27.5	16,289,041	14.0
Residential New Construction	\$60,796,920	2.9	79,441,532	1.1	1,846,071	1.6
Existing Non-Residential	\$874,202,666	41.0	4,074,317,837	54.5	65,980,338	56.8
Non-Residential New Construction	\$169,760,051	8.0	547,246,658	7.3	19,725,897	17.0
Other	\$562,576,155	26.4	724,062,579	9.7	12,397,971	10.7
Total	\$2,132,097,994		7,481,296,847		116,239,318	

These plans will provide lower utility bills, reduce air pollution, and significantly impact the energy savings potential of the existing buildings market. The strategies presented in this report are intended to fill in gaps in existing and planned programs.

Results of Current Programs

Figure 2-3 shows the estimated cumulative savings in GWh that have been achieved by standards and other efficiency programs.

Figure 2-3



These programs have improved the efficiency of energy use in existing buildings through actions such as the following:

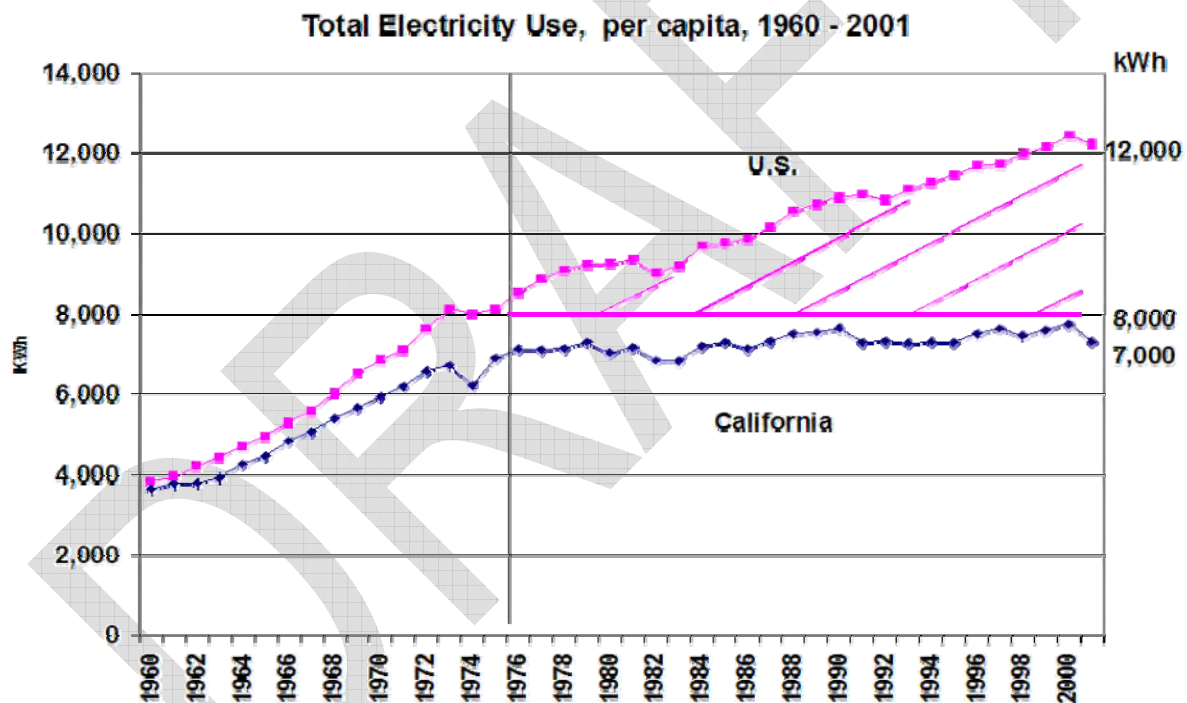
- Between 1976 and 2004 the utilities spent more than \$5.6 billion on energy efficiency programs, and, in any given year, the utilities focused more than 50 percent of their programs on the achievement of cost-effective retrofits in existing buildings. In the last five years, expenditures that are clearly targeted at new construction programs, aiming to increase the efficiency of new buildings beyond the standards in place, amounted to about 15 percent of total expenditures.
- Over half of the energy savings attributed to the Appliance Standards are from the installation of new appliances in existing buildings. Over time, as existing homes and buildings replace their energy-using equipment, the Appliance Standards increase the efficiency of energy use in those homes and buildings.

- While the Building Standards are usually seen as improving energy efficiency in newly constructed buildings, they also apply to all additions and many alterations made to existing buildings and have affected many vintages of existing buildings constructed since they were first enacted in the late 1970s.

Figure 2-4 indicates that while average per capita electricity consumption has continued to increase for the nation as a whole, Californians began leveling off their use in the mid to late 1970s. While contributing to this trend, energy efficient newly constructed buildings can not explain the entire pattern. A significant influence has been from improvements to existing buildings.

The strategies recommended in the chapters that follow are intended to coordinate with these existing efforts and to fill in the gaps identified for additional savings.

Figure 2-4



Green Building Initiative

On December 14, 2004, Governor Schwarzenegger issued Executive Order S-20-04, launching the Green Building Initiative, which establishes a high priority for energy efficiency in existing nonresidential buildings. The Green Building Initiative (the Executive Order and the accompanying Green Building Action Plan) sets a goal to reduce energy use in both state-owned and other nonresidential buildings by 20 percent by 2015, and provides specific direction to accomplish these savings. The CPUC is requested to determine the level of ratepayer-supported energy efficiency and clean power generation funding that should be devoted to achieving the 20 percent goal. The CPUC is also urged to collaborate with the Energy Commission and other organizations to encourage energy efficiency retrofits, benchmarking and building commissioning.

One responsibility placed on the Energy Commission is to aggressively update the energy efficiency standards for nonresidential buildings so that by 2015, the standards will save 20 percent more energy (the standards are expected to be updated three times in that period with effective dates of 2008, 2011, and 2014). The Building Standards support the Green Building Initiative because these savings will occur not only in newly constructed nonresidential buildings, but also in the large amount of floor space that annually undergoes renovation (additions and alterations), which falls within the scope of the standards. The Building Standards are expected to advance the use of building commissioning in California, and special efforts are to be placed on improving compliance. These efforts are to include cooperative initiatives with state license boards. In July 2005, the Energy Commission entered into a Memorandum of Understanding with the Contractors State License Board to launch this effort. Special attention will be placed on achieving contractor compliance with Building Standards requirements for alterations to existing buildings.

The Green Building Initiative also directs the Energy Commission to work with the CPUC, utilities, other governmental agencies and the business community to develop a building energy benchmarking system for all commercial buildings and public buildings in the state. The Energy Commission is to prepare a plan and recommendations for how to accomplish benchmarking in all commercial and public buildings, including benchmarking at time of property sale and the disclosure of benchmarking results to tenants, buyers, and lenders. Implementing benchmarking on this scale is a massive undertaking that will necessarily need to be spearheaded by the utilities.

Furthermore, the Energy Commission is directed to develop guidelines and standards for commissioning activities to achieve operational and maintenance efficiency savings in commercial and public buildings. The Green Building Initiative requests that the California Public Employees Retirement System and the State Teachers Retirement System cut energy use in their real estate investment portfolio by 20 percent by 2015 through retro-commissioning and retro-fitting of energy using systems. The Executive Order also established a Real Estate Industry Leadership Council, made up of commercial real estate industry leaders, to help achieve the Green Building Initiative goals in the private sector.

Finally, specific actions for achieving the 20 percent reduction goal include benchmarking of all state-owned buildings, retro-commissioning of all state-owned buildings with over 50,000 square feet of floor space, and cost effective retrofits in all state-owned buildings.

Residential Energy Conservation Ordinances

Residential Energy Conservation Ordinances (RECOs) put in place by local governments represent commitments to improving existing building energy efficiency and may serve as models for state actions. Two cities, San Francisco and Berkeley, have energy conservation ordinances that apply to existing homes at the time of sale.

San Francisco's ordinance has been in place since 1982 (amended in 1983 and 1991) and applies to single and two-family dwellings, apartment buildings and residential hotels. Residential buildings granted building permits on or after July 1, 1978 are exempt. Energy efficiency measures required by the ordinance include attic insulation, exterior door weatherstripping, water heater insulation, caulking and sealing of building openings, and heating and cooling duct insulation. Water conservation measures such as low flow showerheads and flow restrictors in faucets are also required. Once measures are installed, compliance is checked by either the Department of Building Inspection or a certified private energy inspector and a certificate of compliance is issued. Homeowners pay for the cost of the measures up to a maximum cost for one or two-family dwellings of \$1,300. For buildings with three or more units, the cost is one percent of the assessed property value if compliance occurs before the sale, or one percent of the purchase price if compliance occurs as a result of a sale.

The Berkeley ordinance was first adopted in 1987 and updated in 1991 and includes ten measure requirements triggered at the time of sale or major renovation. These include ceiling insulation of R 30, sealing and insulation of furnace ducts, water heater insulation, low flow shower and faucet fixtures, water pipe insulation, replacement of incandescent light bulbs in common areas of multiple unit structures with fluorescent lamps, exterior door weatherstripping, dampers or other devices to reduce heat loss through chimneys, and water conserving toilets. Inspections are carried out by an independent agent with no financial interest in the installation of the measures. Inspection fees are set by the City Council to avoid unjustified inspection costs to the building owner. The status of residential property compliance with RECO requirements is easily available to homeowners, title companies, realtors and buyers by contacting the City of Berkeley.

Berkeley records indicate that from September 2003 through September 2005, nearly 900 inspections were conducted on over 1,400 units. While 16 to 29 percent of the units did not comply upon the first inspection, only 7 to 9 percent remained non-compliant.

Berkeley, San Francisco and Oakland are currently considering an upgraded regional RECO that will focus on a performance approach to achieve more extensive conservation measures, such as energy-efficient windows.

Several other cities and counties have ordinances in place that require more stringent energy efficiency measures than Title 24. The cities of Santa Monica, San Jose, Davis, and San Mateo and Marin counties are prominent examples. Santa Monica is currently evaluating the potential energy savings and costs that could be associated with a time-of-sale ordinance.

The Federal Energy Policy Act of 2005

The Federal Energy Policy Act of 2005 includes several energy efficiency provisions that have implications for the strategies recommended in this report. Efficiency provisions include consumer and manufacturer tax credits. And new minimum efficiency standards for 16 products. The Act provides tax benefits to homeowners in the form of tax credits. A tax credit is available for tax years 2006 and 2007 of 10 percent of the improvement cost, up to a total of \$500 for the combined two years. Eligible home improvement items include insulation, energy efficient windows, highly efficient central heating and air conditioning equipment, water heaters and gas furnaces, highly efficient furnace fans, energy efficient doors and cool-coated metal roofs. It is not yet clear whether duct sealing and infiltration reduction measures will be included as well. A cap of \$200 is placed on windows, \$300 on central heating and air conditioning systems, \$150 on the cost of a highly efficient combustion furnace (Annual Fuel Utilization Efficiency of 95 percent) and \$50 on highly efficient furnace fans.

These are relatively modest tax incentives, particularly for energy efficient windows which can greatly exceed the cost of replacing a central heating and air conditioning system. Therefore, the window tax credit, while beneficial; to consumers, may result in “free ridership” in that many consumers would make the upgrades without the tax benefits.

Incentives for major upgrades in existing commercial buildings provide a deduction of \$0.60 per square foot per system for upgrading one or two systems including the building envelope, lighting or HVAC systems to be 50 percent more efficient than ASHRAE Standard 90.1 (2001). These incentives apply to upgrades made between August 2005 (the date of enactment) and December 31, 2007. According to the American Council for an Energy-Efficient Economy (ACEEE), the savings threshold to earn tax credit is about twice the level of savings being targeted by most commercial new construction programs.²

Lighting systems are allowed a deduction of \$0.30 per square foot for buildings that achieve 25 percent lighting savings relative to ASHRAE 90.1 (2001) lighting power density requirements and that also use bi-level switching. The credit increases to \$0.60 per square foot for using bi-level lighting and achieving 40 percent lighting savings. The combination of larger savings and this incentive could cause many building owners to remodel the lighting in the existing buildings.

² “The Federal Energy Policy Act of 2005 and its Implications for Energy Efficiency Program Efforts,” Steven Nadel, September 2005.

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The Act also provides for manufacturers of very efficient refrigerators, clothes washers and dishwashers to receive tax credits for appliances sold in 2006 and 2007. The incentive for refrigerators is tiered based on the level of energy efficiency, starting at \$75 and going up to \$175. Efficient clothes washers and dishwashers meeting the 2007 Energy Star® levels are each eligible for a \$100 credit . While the Department of Energy must still specify the 2007 Energy Star® level, these credits should result in lower consumer prices for complying equipment and stimulate sales. Information about manufacturer tax benefits should be included in the Information Gateway and Information at Time-of-Sale Disclosure strategies to alert consumers to possible price reductions for these efficient appliances.

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CHAPTER 3: Energy Savings Potential of Existing Buildings

Characteristics of California's Residential Building Stock

As shown in Table 3-1, the residential building stock is primarily single-family units occupied by the owner. About 72 percent of these homes were built prior to the 1982 version of the Building Standards. Multi-family homes represent the balance of the residential stock; about 73 percent of those units were built prior to the 1982 Standards. Using the 1982 Building Standards as a benchmark, the likely candidates for efficiency improvements would then exceed 8 million homes.

Table 3-1
Residential Building Stock by Year

	Single Family Units	Multi-family Units	Total
1982	5,554,290	2,723,422	8,277,712
1991	6,634,644	3,334,322	9,968,966
2000	7,355,358	3,551,042	10,906,400
2004	7,682,759	3,718,122	11,400,881

Source: *California Energy Commission, 2005 Forecast Data for Residential Buildings.*

Survey data indicate that single-family homes in California use about 7,000 kWh of electricity per year, on average. Multi-family units average about 4,000 kWh per year. These averages vary significantly by location and size and income level of the occupants. They also vary by the age of the home. Older homes tend to use less energy because they are smaller and have a lower saturation of installed central air-conditioning systems. On average, homes built prior to 1996 use less than 6,000 kWh per year, while homes built after 1996 use 20 percent more electricity, or over 7,000 kWh per year. Table 3-2 summarizes the differences between the electricity use of older and newer homes in California.

Table 3-2 provides some indication of where energy savings potential can be found in existing homes. Because of the Building Standards, newer homes tend to have more insulation, better windows, and more energy efficient equipment, such as compact fluorescent lamps and efficient clothes washers, than older homes. Older homes that have central air conditioning are likely to have significantly less efficient equipment.

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Table 3-2
Comparison of Newer and Older Dwellings

	Newer Dwellings (Built after 1996)	Older Dwellings	Percent Difference
Annual Electric Household Consumption (kWh)	7,159	5,960	20
Annual Gas Household Consumption (therms)	468	459	2
Dwelling Size (square feet)	2,039	1,434	42
Number of Residents	3.14	2.93	7
Average Annual Income	\$86,276	\$58,082	49
Percent Single Family	74%	58%	28
Owner Occupied	83%	62%	35
Saturation of Central AC	78%	41%	93
Cooling Degree Days	962	900	7
Cooling Degree Days (those with central AC)	1,119	1,279	-13
Programmable Cooling Thermostat	85%	47%	83
Swimming Pool Saturation	13%	8%	59
Average Number of Computers per Home	1.21	0.93	30
Natural Gas Primary Heating	86%	83%	5
Heating Degree Days	2,050	2,023	1
Exterior Wall Insulation Throughout	91%	51%	77
Attic Insulation	91%	66%	38
Double Pane Windows Throughout	79%	31%	157
Low Flow Showerheads Throughout	71%	54%	32
Average Number of CFLs per Home	2.29	1.74	32
Horizontal Axis Washers	13%	9%	43

Source: *California Statewide Residential Appliance Saturation Study Final Report, Executive Summary*, June 2004, publication no. 400-004-009.

The average annual energy use per home also varies significantly by climate zone within California, ranging from about 5,000 kilowatt hours (kWh) in the cooler zones to 8,000 kWh or more in hotter zones. In addition, the type of dwelling unit affects energy use. Single family units tend to be larger and have more energy using equipment than multi-family units.

It is worth noting that with energy efficiency gains in new home construction over the years, overall average electricity use has remained relatively unchanged (see Table 3-2, above.) Since newer homes are generally larger and in hotter climate zones than older homes, without these gains, average electricity use would have undoubtedly increased.

Characteristics of Nonresidential Building Stock

California's nonresidential building stock is much more diverse than the residential. Table 3-3 shows that about 46 percent of nonresidential building space was built before the 1978 Building Standards. Large offices, retail and non-refrigerated warehouses represent approximately half of the total nonresidential space. These data indicate that over 5 million square feet of nonresidential buildings may benefit from efficiency upgrades amounting to significant further savings.

Table 3-3
Percent of Nonresidential Floor Stock Area Built Prior to 1978
(Millions of Square Feet)

Year	Pre-1978 Stock	Current Total Stock	Percent of Pre-1978 Stock to Current Total Stock
Small Office	264.6	646.3	41
Restaurant	143.9	316.8	45
Retail	799.0	1,824.4	44
Food Store	220.4	476.7	46
Non Refrigerated Warehouse	611.6	1,480.5	41
Refrigerated Warehouse	39.3	95.0	41
School	581.2	872.6	67
University	321.7	547.7	59
Hospital	239.3	538.2	44
Hotel	219.9	526.7	41
Other	974.3	2,039.1	48
Large Office	833.7	2,035.7	41
Total	5,248.9	11,399.7	46

Source: California Energy Commission, 2005 Forecast Data for Nonresidential Buildings.

Estimated Potential Savings for Existing Buildings

Table 3-4 compares total statewide consumption of existing buildings to the technical and economic potentials for energy and demand savings based on earlier work (see footnotes below). Potential cost effective savings represent from 15 to 18 percent of current statewide consumption.

Table 3-4
Energy and Demand Savings Potentials

Category	GWh	MW	Million Therms
Total Statewide Consumption	280,000	55,000	14,344
Residential	70,595	15,700	5,000
Commercial	80,000	16,500	2,100
Efficiency Technical Potential³	37,498	9,316	3,365
Residential	19,710	5,643	2,148
Commercial	14,721	3,673	751
Efficiency Economic Potential⁴	24,129	5,482	Not Reported
Residential	11,593	2,906	
Nonresidential	12,536	2,576	

³ These values were assembled from four efficiency potential studies authored by F. Coito and M. Rufo of Xenergy, Inc., prepared for Pacific Gas and Electric Company, 2003 and 2001. The reports are available at www.calmac.org.

⁴ Source: Derived from the Energy Commission's Staff Report *Proposed Energy Savings Goals for Energy Efficiency Programs in California*, publication no. 100-03-021, prepared in support of the 2003 Integrated Energy Policy Report.

CHAPTER 4: Recommended Residential Strategies

California Home Energy Rating System Program

In 1992, SB 1207 first provided the Energy Commission with the authority and responsibility to establish a statewide home energy rating program which would have the following elements:

- Consistent, accurate, and uniform utility ratings based on a single statewide rating scale
- Reasonable estimates of potential utility bill savings, and reliable recommendations on cost-effective measures to improve energy efficiency
- Training and certification procedures for home raters and quality assurance procedures to promote accurate ratings and to protect consumers
- Procedures to establish a uniform reporting system for information on residential dwellings
- Labeling procedures that meet the needs of home buyers, homeowners, renters, the real estate industry, and mortgage lenders

Once the California Home Energy Rating System (HERS) program was established, the Energy Commission was to develop and publish an informational booklet to inform homeowners, rental property owners, renters, sellers, brokers and the general public about the program. Real estate sellers and brokers were to be responsible for disclosing the program and furnishing home purchasers with the information.

Phase I of the HERS program was accomplished in 1999. That phase set up the basic operating framework of the program, including training and certification procedures for raters, and quality assurance procedures, and data collecting and reporting requirements. The Phase I regulations, adopted by the Energy Commission, established the role of the HERS provider, an entity to:

- Train, certify and monitor home energy raters
- Conduct complaint investigations
- Collect data and report on services that raters provide

Through this process, the services of HERS raters are made available to the market. Infrastructure costs are included in the cost of the services, and are reimbursed by those benefiting from the services. Under Phase I, raters provide third-party diagnostic testing and field verification services to ensure quality construction and installation of efficiency features that are prone to construction defects in newly constructed homes.

Phase II, which was delayed due to the 2000 electricity crisis, will put in place the remaining elements needed to provide oversight for energy ratings of existing residences.

The Efficiency Committee believes that home energy ratings provide valuable information regarding the existing condition of energy efficiency measures in a home

and the cost effectiveness of alternatives to improve its energy use. That information may be material to the value and desirability of a particular property and is necessary if owners are considering investing in energy efficiency improvements. The Efficiency Committee believes the Energy Commission should complete Phase II of the California Home Energy Rating Program proceeding by establishing an oversight function for home energy ratings, consistent with legislative intent.

Evaluation of Strategies for Residential Buildings

The Efficiency Committee proposes five strategies for reducing peak load and energy use in existing residential buildings. These strategies were evaluated based on their applicability at important trigger events, their usefulness in closing gaps in existing programs, and their ability to reduce known barriers, build supporting infrastructure, and achieve significant energy savings cost effectively.

In developing the strategies, we reviewed the 2004-05 energy efficiency program portfolio for the state's four IOUs' which consisted of close to 100 programs offered by a combination of the IOUs, partnerships between the IOUs and local governments, and non-utility program implementers. Most programs offered some education, training or information component. Audits, rebates, direct installation of measures, and design assistance were examples of the portfolio's offerings.

We identified known and potential market or regulatory barriers to implementing the strategies and the actions needed to overcome them. Market barriers, for example, may include high first cost, life-cycle cost, payback period, hidden or unexpected costs, uncertain reliability and performance, design limitations, and product options. Further discussion of barriers is provided in the consultant report *Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings*.

The Efficiency Committee also considered the interaction among stakeholders in adopting energy efficiency improvements. For example, the homeowner's selection of a contractor is based on a large number of factors. Also, decisions are influenced by elements such as technology choices, building codes, or contractor certifications.

Finally, market conditions, strategy costs and energy savings are also key elements to consider in measuring the value of a proposed strategy.

Table 4-1 shows the estimated energy savings, costs, and cost effectiveness of each residential strategy.

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Table 4-1

Residential Annual Energy Savings Potential, Costs, and Cost-Effectiveness

Strategy	Gigawatt hours	Megawatts	Million therms	Program Cost (\$million)	Participant Benefit Cost Ratio	Total Resource Cost Benefit Cost Ratio
Information at Time-of-Sale Disclosure	175 - 186	52 -55	9 – 10	4 - 53	2.34 – 2.90	1.17 – 1.29
Information Gateway	62 - 259	18 - 75	6 - 27	39.4	2.57	1.07
Whole Building Diagnostic Testing	45 – 54	40 - 48	2	11.9	1.65	1.09
Assistance to Affordable Housing	16 – 34	27 - 56	2 – 5	26.6	3.01	1.27
Equipment Tune-up	16 – 19	21 - 25	4	4.9	1.98	1.11
Total	314 - 552	158 - 259	23 - 48	86.8 – 135.8		

The data for the residential sector analysis come primarily from the California Statewide Residential Sector Energy Efficiency Potential Study⁵, the California Statewide Residential Appliance Saturation Study (RASS)⁶ and additional secondary research conducted for this project by the consultant team⁷. Basic data on existing building housing stock and the energy savings potential of common energy efficiency measures were taken from the statewide residential potential study. Updated values on appliance unit energy consumption (UEC) and appliance saturations were taken from the RASS. The RASS data were also used to segment the residential building stock into sub-segments by income and ownership type to better understand energy savings potential of the intervention strategies within each segment.

The efficiency potential study segmented the building stock into buildings built prior to the Building Efficiency Standards and those built after the Standards. The residential building stock for each of these vintages was divided into segments representing owners and renters in three income groups (less than \$35,000 per year, \$35,000 - \$75,000 per year, and over \$75,000 per year household income) according to the fraction of the total population represented by each segment. The multi-family data were further segmented into town homes, 2 to 4 unit buildings, and over 4 unit buildings. The building stock data from the statewide residential potential study are broken out by climate zone, but since the income and ownership segments are defined at a statewide level, these fractions were applied uniformly across each climate zone. UEC data from RASS study by building type were applied to the segmented population data. Since the UEC data in the RASS are also statewide, the UEC distributions by climate zone from

⁵ *California Statewide Residential Sector Energy Efficiency Potential Study* (volumes 1&2), Prepared for Pacific Gas and Electric Company by Xenergy, Inc., 2002, available at www.calmac.org.

⁶ *California Statewide Residential Appliance Saturation Study*, Prepared for the California Energy Commission by KEMA-Xenergy, Inc., Publication number 400-04-009, 2004.

⁷ See *Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings, Appendices*. Prepared for the California Energy Commission by Architectural Energy Corporation, Publication number CEC-400-2005-011-F-AP, 2005.

the statewide residential potential study were used to assign UECs by building type and climate zone.

The level of increased market penetration of energy efficiency products and services was estimated by a group of industry experts who provided their best estimates of market penetration for specific strategies deployed under different levels of program design and promotional efforts⁸. This expert opinion approach consisted of two levels of penetration assessments that were then merged into one estimate. In the first level a set of “strategy experts” were identified, those involved in the industry that would be affected by the strategy. These experts were then interviewed to gain their opinions on the need for the strategy, operational and design characteristics that would be important to consider, and their estimates of the strategy’s market penetration levels.

The second level consisted of the consultant research team estimating market penetration impacts. This team included consultants with experience in evaluating energy initiative designs, operations and market strategies, and knowledgeable on human behavioral responses to energy initiatives and the efficiency technologies used to realize savings. In this “second level” effort, the estimates and notes from the interviews were examined to help identify range estimates for the various strategies. The strategies were broken down into different design components that would be expected to influence customer demand and participation rates. Following the generation of design components, a series of expert-opinion-estimated penetration rates based on the strategy design characteristics was established. A range of expected penetration rates for each design characteristic within each strategy was identified, along with an average overall expected penetration level for the strategies. Penetration levels were developed for a set of progressively aggressive approaches for pursuing each strategy, producing a corresponding increase in penetration levels.

The expected penetration level was then used to estimate the amount of energy that could be saved if the strategy were implemented. The impact analysis used a most likely penetration level and a highest estimated penetration level. The estimates presented in this assessment assumed:

- strategies would operate in a non-supply emergency environment most of the time, with some isolated short-duration periods of limited supply constraints during peak periods in June, July, August and September, and
- stability of electricity and natural gas prices

The strategies would be expected to result in added penetration in restricted supply environments or in a situation in which energy costs increase substantially above the rate of inflation.

The Efficiency Committee recommends the following strategies for existing residential buildings:

⁸ More accurate penetration estimates can be provided by developing specific concept initiatives and conducting primary market research (surveys, focus groups and so on) within the target markets to measure expected demand. This research approach was beyond the scope of the AB 549 project.

Information at Time-of-Sale Disclosure

In California, over 600,000 existing homes are sold each year, triple the number of new homes built, and, with the exception of two local ordinances, there is with no requirement for improving the efficiency of these buildings at the time ownership changes. Current energy efficiency programs do not systematically target time-of-sale opportunities. Some sellers may provide the potential buyer with past utility bills, which is a step in the right direction, but this is not a routine nor a sufficient activity. Utility bills can vary significantly based on occupant behaviors and, therefore, are not necessarily a reliable indicator of home energy efficiency. Home energy ratings would offer the customer more information, including cost effective options for improving energy efficiency. However, for HERS ratings to be available as a standard part of real estate sales, there would need to be more qualified home energy raters and the real estate industry would have to make HERS ratings a regular part of the sales transaction. The purchase of a home is an important opportunity to achieve energy efficiency improvements. The buyer wants to know what size energy bills to expect, the condition of the energy-related features and equipment, and the potential for improvements. The buyer may be motivated to consider upgrades that will make the home more affordable to operate and more comfortable, and the seller may be motivated to make upgrades to improve the prospect of a sale. New financing can be considered, and upgrades can be included in the mortgage at relatively attractive interest rates.

The Efficiency Committee believes that ultimately there should be a statewide requirement for the disclosure of home energy ratings at the time-of-sale. Consulting with the real estate community and the home energy rating industry, we reviewed several options for addressing the time-of-sale opportunity. Our conclusion is that there are a number of steps that need to be taken before it is practical to obligate disclosure of home energy ratings for every home sold in California. We recommend taking steps to move expeditiously in that direction.

First, we propose developing and making available to home purchasers an informational booklet about home energy efficiency. Current law (Civil Code 2079.10) requires that real estate sellers and brokers provide such a booklet once one has been developed by the Energy Commission. A first version of this booklet will:

- provide buyers, sellers, brokers, and appraisers information about the opportunity to invest in energy efficiency improvements at the time-of-sale,
- explain the desirability of obtaining utility bills from the seller,
- suggest questions that the potential buyer might ask the seller to assess future energy bills,
- explain the right of the purchaser to ask for an energy inspection (pursuant to Business and Professions Code 7195 (a) 2), and
- provide information on utility programs and services.

Once an informational booklet is available, the Energy Commission would conduct a one-year, voluntary pilot program, in collaboration with the utilities and the real estate

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industry, to demonstrate the value of the information to brokers, sellers, buyers, purchasers, appraisers and lenders.

Meanwhile, the Energy Commission would conclude the Home Energy Rating, Phase II proceeding. Subsequent to the completion of the proceeding, and with the experience gained from using the informational brochure to initiate energy discussions during the sales transaction, a second version of the HERS program booklet would be developed. It would fully explain the HERS program to buyers and sellers, including the need to disclose a rating prior to sale.

The Energy Commission would conduct training for brokers, sellers, appraisers, and lenders about the program. Also, the HERS providers would initiate training of the additional HERS raters that would be necessary to meet increased demand. Appraisers would be able to take rating information into account in establishing the market value of the property.

The Energy Commission would work with the California Public Utilities Commission and the utilities to allocate efficiency program funds to provide incentives for buyers and sellers to obtain ratings and to implement energy efficiency improvements recommended by the rating. Based on experience from the pilot, the Energy Commission would initiate a two-phase program of mandatory disclosures of energy ratings. Phase 1 would require disclosure of ratings for homes built prior to 1982 and would operate for one year. The majority of all existing homes in California fall into this category (72 percent, or over 8 million homes as shown in Chapter 3, Table 3-1). Phase 2 would extend mandatory disclosure to all homes being sold.

Although the rating would be mandatory, it would be the buyer's voluntary decision to pursue, or not pursue, energy efficiency upgrades. While home energy ratings are no guarantee of action on the part of the buyer, they could provide material information about the energy use and potential for savings in the 600,000 home sold each year in California. They are superior to the current, occasional practice of reviewing utility bills in that they are based on a physical inspection of the energy-using features of the home, provide a comparable rating to other homes, and offer an assessment of cost effective measures that will improve the energy efficiency of the home. In addition, the home energy rating can inform the buyer about financing options as well as utility and non-utility incentives.

About 136 GWh of electricity could be saved each year if the homes built prior to 1982 reduced their use by 5 percent. This figure climbs to 189 GWh if all homes sold each year reduced electricity use by 5 percent as a result of the information obtained in a home energy rating.

The program's cost ranges from \$4 million in the early one year pilot program to \$53.5 million annually in later mandatory years. The Energy Commission would fund the work necessary to develop the booklet and to conduct the HERS proceeding. The utilities would provide incentives during the pilot project. The cost of administering the training, certification and oversight of HERS raters would be covered by the HERS providers approved by the Energy Commission to perform those duties, and would be recouped in

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the private market as a value-added service. Property sellers and buyers would pay for the HERS rating, depending upon the details negotiated in the home sales agreement. The costs of implementing the energy efficiency measures recommended by the rating, over and above the incentives provided by the utilities, would be covered by the buyer or seller, and would commonly be included in mortgage financing associated with the sale.

Annual average energy savings range from 87 to 164 GWh and 7 to 38 megawatts (MW) are estimated for this strategy, with smaller savings in the first, voluntary years and larger savings in the later mandatory years.

The Efficiency Committee recommends that this strategy be implemented through the following actions:

- The Energy Commission, in collaboration with the utilities, the California Association of Realtors®, the Department of Real Estate and HERS providers should develop an informational booklet to offer buyers, sellers, brokers, and appraisers information about energy use and cost. The booklet should primarily motivate prospective buyers to elicit information on energy use in homes. It should also identify available programs and services.
- Once the Energy Commission has concluded its HERS proceeding, homes being sold that were built prior to the 1982 Building Energy Efficiency Standards should receive a HERS rating. The rating should be easy to understand and include a description of cost effective upgrades available to the buyer. These potential upgrades should be described in sufficient detail to allow a prospective homebuyer to apply for an Energy Efficient Mortgage.
- The Energy Commission, the Department of Real Estate and the California Association of Realtors® should develop coursework for training real estate agents and other industry professionals on topics related to disclosure of energy efficiency and home energy rating information.
- The Department of Real Estate should make disclosure of energy efficiency and home energy rating information part of its real estate agent coursework.

Current utility programs should provide incentives for buyers and sellers to obtain ratings and to implement energy efficiency improvements recommended by the rating. The incentive should be set, at a minimum, to cover portions of the rating itself and the efficiency measure(s) cost.

Table 4-2
Action Plan for Time-of-Sale Disclosure Information

Activity	Lead Organization/Support Organizations	Timeframe
Form strategy development group from Energy Commission, industry experts and service implementers	Energy Commission/ Department of Real Estate, Ca Assoc of Realtors®, IOUs, HERS providers	2006
Assess information needs, funding resources, develop first version of informational booklet	Energy Commission/ Ca Assoc of Realtors®, IOUs, HERS providers	2006
Conduct and complete HERS proceeding	Energy Commission	2006 - 2007
Develop second version of informational booklet	Energy Commission/Ca Assoc of Realtors®, IOUs, HERS providers	2007
Develop training materials	Energy Commission/HERS providers, Ca Assoc of Realtors®, Department of Real Estate	2007 – 2008
Conduct training	Ca Assoc of Realtors, HERS providers/Department of Real Estate, Energy Commission	2007-2008
Assess pilot program results, design and launch phase 1 mandatory program for pre 1982 homes	Energy Commission/ Ca Assoc of Realtors®, IOUs	2007
Design and launch phase 2 mandatory program	Energy Commission/ Ca Assoc of Realtors®, IOUs	2008
Evaluate program and modify to improve	Evaluation Firm	2008-09

Information Gateway

The Information Gateway strategy provides an education and referral service, directing homeowners and property managers to information and services, including in-depth online energy audits and referrals to existing energy efficiency programs. Customers would receive feedback on their energy consumption, compared to similar customers, through utility websites or mailings. It would function continuously and, therefore, does not depend upon on any specific trigger event.

Elements of the strategy would include:

- Targeting buildings with the greatest potential for energy savings, requiring utilities to compile energy use data to identify those customers meeting specific targeting criteria.
- Providing feedback on customer energy use through utility websites.
- Providing online home energy audit information in a multi-level format that allows the customer to explore their energy use patterns and options for saving energy. Additional levels of energy audits (e.g., over-the-phone, in-person) would be provided to targeted and/or interested customers.

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- Connecting customers with opportunities for financing energy efficiency upgrades either through existing programs or through a separate program.
- Providing customers with energy efficiency program marketing materials through bill stuffers, online customer service applications and media campaigns.

This strategy would be undertaken primarily through utility websites where customers would receive feedback on their energy consumption compared to like customers. The feedback would be formatted to motivate customers to delve deeper into understanding their energy use patterns and options for saving energy. While California utilities currently offer online audits, this strategy would represent an enhancement to those services.

At the Efficiency Committee workshops, participants noted the limitations of current online audits and customer access to online services and the need for much larger media campaigns. The Efficiency Committee also recognizes the difficulty of estimating savings from an information strategy and believes that it is reasonable to expect 20 percent participation as indicated in the assumptions below. However, it is possible to witness much greater participation depending upon energy prices and other factors, therefore, this strategy exhibits a much wider savings range than others.

Annual energy savings from the Information Gateway strategy range from 62 to 259 GWh. It would cost approximately \$40 million per year and be implemented by each of the utilities under the Public Goods Charge (PGC)-funded programs.

The Efficiency Committee recommends the strategy be implemented through the following actions:

- Each utility should establish a centrally-administered information gateway for residential energy efficiency information and referrals to efficiency programs and services offered by utilities, non-utility program implementers and the Energy Commission. In providing information, the utilities should first evaluate energy bill information for all of their customers to determine who are the highest energy users (this should be done based on total energy use and by comparison with other factors, such as zip code, building square footage and customer type). When information on useful comparison factors are not known to the utility the utility should request voluntary data from the customer. The utilities should encourage customers to complete online energy audits or otherwise collect information from customers that would be useful to "benchmark" their energy use compared to other customers. The utilities should place priority on encouraging customers with the highest energy use or the greatest potential for energy savings to take energy efficiency actions. This could be accomplished through online messages to individual customers or through mailings or utility initiated technical assistance. All residential building types should be included, with the information focused at residents, property owners and/or property managers as appropriate. An advisory group of utilities, third party implementers and industry experts could assist in shaping and coordinating the effort and should be formed in 2006.

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- The utilities should offer feedback on individual customer energy use through their websites. Customers without access to the internet, or those that do not use online billing, should be provided written communications.
- The home energy audit information should be provided on a multilevel format that allows the customer to explore their energy use patterns and options for saving energy to as much depth as necessary to motivate action. As discussed above utilities should collect building description information and deliver audit results online, over the phone, through the mail or in person as necessary to reach targeted customers. Local governments and community-based organizations could help reach targeted customers.
- The audit report should include marketing materials and referrals that are tailored to the customer's needs and that provide linkages to existing programs and services available for the customer to take action on the audit findings.
- The utilities should take steps to assure easy access to financing assistance. Financing assistance could take the form of either on-bill or off-bill financing offered through either existing programs or a separate initiative, to motivate customers to make efficiency upgrades. Utilities should inquire whether customers find this financing to be easily accessible and determine what actions the utility could take to address access concerns.
- A media campaign should be used to advertise and promote the Information Gateway strategy.
- The CPUC and utilities should investigate utility resources necessary to upgrade utility billing information systems to offer customers more interactive energy efficiency information.
- The CPUC should encourage utilities to determine and claim credit for energy savings that can be linked to information programs.
- Procedures should be developed to protect the confidentiality of customer billing data while allowing non-utility implementers to work with high energy use customers.

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Table 4-3
Action Plan for Information Gateway

Activity	Lead Organization/Support Organizations	Timeframe
Form strategy development group from Energy Commission, industry experts and service implementers	Energy Commission	2006
Conduct market demand and participation analysis	Energy Commission/Contractor	2007
Conduct detailed review of feasibility, desirability and potential benefits, barriers and approaches	Energy Commission	2007
Examine current homeowner identification systems and contact approaches and assess their applicability	Energy Commission	2007
Review designs and approaches for base lining homes and identifying priority participants	Energy Commission	2007
Develop a coordinated information delivery program that reaches all homeowners, provides covered services and include design strategies	Energy Commission	2007
Assess detailed program cost and cost/benefit potentials for developing strategy under various delivery approaches	Energy Commission	2007
Identify best approaches for information delivery and incorporate into delivery system strategy or devise new system that uses current utility or other means	Energy Commission	2007
Conduct strategy go/no-go decision criteria and make decision based on criteria and available funding	Energy Commission	2008
Form delivery development team to design and test pilot program consistent with funding capability	Energy Commission/IOU	2008
Establish financing programs, potentially link to On-Bill-Financing Programs	Energy Commission/Selected Implementer	2008
Benchmark residential buildings with the IOUs, using SDG&E's 2007 Home Energy Consumption Tool benchmarking efforts as a potential model	IOU/Energy Commission/Selected Implementer	2009
Target customers	IOUs and Selected Implementer	2009
Market services	Selected implementer, linked with Flex-Your-Power and other outreach and strategy-focused marketing efforts	2009
Implement program	IOUs and/or non-utility program implementers	2009
Evaluate program and modify to improve, continue or eliminate	Evaluation Firm	2009 - 2011

Equipment Tune-ups

The residential equipment tune-up strategy focuses on increasing the frequency and effectiveness of heating, ventilation and air conditioning (HVAC) system tune-ups and maintenance services. Homeowners would have HVAC technicians test and, if indicated, correct airflow requirements, refrigerant charge, and duct leakage during equipment replacement. Currently, the Building Standards mandate proper refrigerant charge and duct sealing or the installation of a thermostatic expansion valve (TXV) when equipment is replaced. The Energy Commission should consider adding, in future standards, the checking of proper airflow, as well as refrigerant charge for package air conditioners. In addition, mechanisms should be considered to encourage these measures at time-of-sale when home ownership changes, starting with highlighting the importance of these measures in the time-of-sale informational booklets. The strategy would require increasing numbers and the training and certification level of HVAC contractors.

Once installed, HVAC systems are typically ignored until they fail. Homeowners do not have experience in determining if a system is operating properly and lack confidence in the industry to remedy problems. The HVAC industry largely relies on rules of thumb when replacing or servicing these systems and, because of strong seasonal demand, technicians are often pressed for time when servicing a unit which can lead to later HVAC performance problems.

Approximately 65 percent of California's 12.2 million households have central air conditioning and would therefore be candidates for this strategy. The estimated energy savings range from 16 to 19 GWh. This strategy was determined to be cost effective with favorable participant and the total resource cost/benefit ratios. Tune-ups in multi-family applications are particularly appealing since the cost per transaction is lower than in the more diffuse single family market.

The Efficiency Committee recommends that this strategy be implemented through the following actions:

- Training organizations, trade associations and the Energy Commission should develop technical training for certification of HVAC technicians.
- Funding should be earmarked for community and vocational schools with HVAC technology programs or starting HVAC programs so that training opportunities are increased to meet the need for additional qualified technicians.
- A media campaign should advertise and promote HVAC performance information to educate consumers and promote industry certifications.

Table 4-4
Action Plan for Residential HVAC Tune-ups

Activity	Lead Organization/Support Organizations	Timeframe
Review evaluation and technical reports; conduct assessment and further refine potential savings	Energy Commission	2006
Conduct program market demand and participation analysis	Energy Commission	2006-2007
Develop program design and funding requirements	Energy Commission	2007
Conduct strategy go/no-go decision criteria and make decision based on criteria and available funding.	Energy Commission	2007
Develop stakeholder group with strong legislative influence that can support effort over a reasonable timeline	Energy Commission	2007
Design pilot program development and implementation strategies consistent with funding	Energy Commission	2007-2008
Develop technical training approach for pilot area	Energy Commission/North American Technician Excellence	2008
Design marketing and roll-out approach	Energy Commission/Marketing Firm	2008
Implement technician training and stage the marketing rollout	Energy Commission	2009
Certify technicians	NATE	2009
Rollout initiative in pilot area	Energy Commission/Implementer	2009
Inform and educate consumers	Flex-Your-Power/IOUs	2009
Evaluate program and modify to improve, continue or eliminate	Evaluation Firm	2009 - 2010
Phase in mandatory requirements	Energy Commission	2011

Whole Building Diagnostic Testing

The whole building diagnostic testing strategy involves evaluating house performance as an integrated system rather than as a number of unrelated parts. Climate, building materials, building assembly, occupant interaction, and mechanical equipment design and installation all affect the “house as a system” performance. Under this strategy technicians would identify flaws in construction or operation, use the diagnostic tools to guide repairs, and verify improved performance.

A detailed diagnostic evaluation allows a technician to understand building performance issues and implement measures that improve building comfort, health and safety, and energy efficiency. At the time of remodeling, synergistic benefits are likely to be realized. For example, when coupled with an air conditioning retrofit, other energy efficiency improvements may contribute to reduced equipment size of the replacement, saving the homeowner additional money. The whole building diagnostic approach represents a more comprehensive way of addressing household energy issues and more thorough testing and remediation than the residential air conditioning tune-up strategy.

The energy implications of whole building diagnostic testing services are important, but may be secondary to issues of comfort, health and safety. Significant non-energy

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benefits provide leverage in implementing energy efficiency, since homeowners highly value comfort, health and safety enhancements.

For many of California's 5.6 million homes built prior to 1982, whole building diagnostic testing offers the potential for significant energy and demand savings in addition to non-energy benefits. Due to the comprehensive nature of the whole building approach, it is a more costly approach than efforts that focus on a single energy efficiency measure. The higher cost of the whole building approach may not be cost effective through reduced energy bills except for high energy users. However, homeowners using whole building testing often find it valuable and worth the cost due to the non-energy benefits that are realized. Non-energy benefits could be included in cost effectiveness calculations and efforts to engage the insurance industry in exploring the risk reduction benefits of whole building diagnostic testing services should be pursued.

The whole building strategy could potentially be tailored to target:

- sub-regions where peak demand is straining the local transmission and distribution system infrastructure.
- situations where a standard home energy rating has identified problems that need to be addressed through a more rigorous approach.
- homes that have been shown to have higher than normal energy consumption that suggests an energy related problem may exist.

Barriers to whole building diagnostic testing include a lack of qualified contractors to perform the work, undervaluing the non-energy benefits such as comfort and indoor air quality, and the extra expense associated with diagnostic testing and whole building retrofits.

The California Building Performance Contractors Association currently conducts whole building system training which involves four days of classroom education and two days of field work. About 100 contractors have been trained to use the whole building approach so far, but many more would be needed to implement this strategy if consumers began to request the service in large numbers.

The Efficiency Committee received supportive comments from the public on this strategy. The estimated energy savings range from 45 to 54 GWh. This strategy was determined to be cost effective for participants, but not clearly cost effective from a total resource cost perspective.

The Efficiency Committee recommends that this strategy be implemented through the following actions:

- The Energy Commission and the California Building Performance Contractors Association should collaborate to develop the necessary training .
- The Energy Commission should permit qualified contractors to self-verify HVAC performance based on documented testing protocols.

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- The CPUC should investigate methods of valuing non-energy benefits in cost effectiveness calculations.
- The Energy Commission should engage the insurance industry in exploring the risk reduction benefits of whole building diagnostic testing services.
- A media campaign should advertise and promote the use of whole building diagnostic testing and qualified contractors.
- The Energy Commission should focus the whole building strategy to target sub-regions where peak demand is straining the local transmission and distribution system infrastructure, in situations where a standard home assessment has identified problems that need to be addressed through a more rigorous approach, and for homes that have been shown to have higher than normal energy consumption.

Table 4-5

Action Plan for Whole Building Diagnostic Testing

Activity	Lead Organization/Support Organizations	Timeframe
Review evaluation and technical reports, conduct assessment and further refine potential savings	Energy Commission	2006
Conduct program market demand and participation analysis	Energy Commission/Market research firm	2006-2007
Develop program design and funding requirements	Energy Commission	2007
Conduct strategy go/no-go decision criteria and make decision based on criteria and available funding.	Energy Commission	2007
Design program development and implementation strategies consistent with funding	Energy Commission	2007
Review and revise technical training approach	Energy Commission/ California Building Performance Contractors Association (CBPCA).	2007
Investigate valuation of non-energy benefits	CPUC	2007
Engage insurance industry	Energy Commission	2007
Design targeting and marketing approach	Energy Commission/Marketing expert	2008
Train contractors in target area	CBPCA	2008
Market and roll-out program in target area	Energy Commission with Flex-Your-Power and other outreach efforts	2008
Evaluate program and modify to improve, continue or eliminate	Evaluation Firm	2008 - 2009

Assistance to Affordable Housing

Multi-family apartments and condominiums represent 31 percent of the total housing stock in California. About 56 percent of multi-family occupants earn less than \$35,000 per year, so about 17 percent of the total units in the state can be characterized as affordable multi-family housing. The combination of having units occupied by low income tenants and the “split incentive” situation, in which tenants pay the bill and the building owners pay for improvements, makes this group especially hard to reach.

The financing options to implement energy efficiency improvements in affordable housing differ from those available to standard property owners. The owner or manager of an affordable housing unit may apply for financial support to the California Department of Housing and Community Development (HCD), the California Tax Credit Allocation Committee (CTCAC), the California Housing and Finance Agency (Cal HFA), and possibly other sources for project financing. Resources include tax-exempt bonds of which Cal HFA is one of the main providers, the CTCAC, and the multi-family housing program that is administered by HCD. Nearly every type of affordable housing is associated with one if not multiple agencies. In most cases, developers use both the tax-exempt bonds from the California Debt Limit Allocation Committee (CDLAC) and tax credit financing to preserve the project as affordable. In affordable housing projects, tax credits are involved in nearly 80 percent of the projects.

The following elements are envisioned for a coordinated strategy for affordable multi-family housing:

- Technical assistance

The utilities should offer information, training and technical support services to housing property and asset managers, including energy audits and technical assistance to implement cost-effective upgrade projects. State housing agencies, local housing authorities and non-profit agencies generally do not have the expertise to properly evaluate and manage energy efficiency improvement projects. Provision of utility bill tracking software to the property managers and training on its use would help highlight problems.

- HVAC tune-up

The utilities energy efficiency programs should provide new funding for HVAC system tune-up, retro-commissioning and operations and maintenance activities. Housing authorities generally lack the funds for HVAC tune-ups and retro-commissioning projects.

- Subsidized housing tax regulatory process

Developers that participate in subsidized housing programs generally receive tax credits and other financial incentives for their investments in low-income housing.

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Energy ratings and energy efficiency upgrades should be required as a condition of participation in these programs. California should not be subsidizing lower efficiency construction practices when better practices are cost-effectively available that help lower tenant costs.

- Efficiency Improvements at the time of rehabilitation

Housing rehabilitation projects are frequently invasive to the point where tenants are relocated during renovation, providing the opportunity to upgrade major building systems such as windows, insulation, common area lighting, HVAC and water heating. At this trigger point, diagnostics and measure verification should be completed, reducing “per unit” costs.

- Interagency partnerships between state housing agencies and the Energy Commission.

These partnership would provide technical support services to local housing authorities, non-profit organizations and project developers. The Energy Commission has been encouraged to offer technical support services regarding energy efficiency to Cal HFA, HUD, CTCAC and SDLAC similar to the current technical assistance program for public facilities.

- Energy ratings

State housing agencies should authorize the use of existing state funding sources or PGC funding should be used to cover the cost of the energy rating and whole building energy audits. Cal HFA has a predevelopment loan program, which covers both pre-construction and/or pre-acquisition expenditures. Energy ratings and audits would be an eligible cost under this program; or audit costs would be a reimbursable item for successful projects. When a loan is closed with Cal HFA the costs should be folded into the financing package without requiring a separate application for predevelopment. Energy ratings should be required as a condition for receiving the energy efficiency funding.

- Revision of housing authority utility allowances to reflect energy efficiency.

By lowering the utility allowance for housing authority subsidized properties to reflect efficiency improvements, property owners would be permitted to charge higher rents since tenant utility bills would be lower. Property owners that invest in energy efficiency upgrades are currently penalized in the sense that utility allowances for more efficient properties are the same as for conventional properties so that owners are not able to charge these higher rents.

- On-going energy efficiency training to operating and maintenance personnel, property managers and asset managers.

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Property managers do not typically have expertise or resources to carry out an energy audit and implement its findings. In addition, high turnover rates among operations and maintenance staff mean that training in energy efficiency must be consistent and continual. Training should be developed in partnership with HCD and housing management associations

The estimated energy savings range from 16 to 34 GWh. This strategy was determined to be cost effective with favorable participant and the total resource cost/benefit ratios. Savings could be significantly higher by applying features of this strategy to multi-family properties other than low income.

The Efficiency Committee recommends that this strategy be implemented through the following actions:

- Information, training and technical support services should be offered to affordable housing property and asset managers, including energy audits and technical assistance to implement cost-effective upgrade projects. Utility bill tracking software and appropriate training should be introduced for use by property managers
- The Energy Commission and housing authorities should work together to highlight property rehabilitation as key trigger events for efficiency upgrades. At this time, diagnostics and measure verification can be completed, reducing “per unit” costs.
- The Energy Commission should explore possible funding sources for HVAC system tune-ups, retro-commissioning and operations and maintenance programs targeted at multi-family properties.
- The Legislature should require energy ratings and energy efficiency upgrades for properties that participate in subsidized housing tax credit programs and identify possible funding sources, such as the Public Goods Charge, to offer incentives to lower the cost of ratings and whole building energy audits. Services should be offered to help developers fill out participation forms, arrange for a rating and determine equipment choices. Energy ratings and audits should be an eligible cost or a reimbursable item for successful projects.
- Interagency partnerships should be developed to provide technical support services to local housing authorities, nonprofit organizations and project developers.

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Table 4-6
Action Plan for Affordable Housing

Activity	Lead Organization/Support Organizations	Timeframe
Form strategy development group of experts	Energy Commission	2006
Review research and form consensus on program design	Energy Commission	2006
Obtain funding to support pilot program	Energy Commission	2007
Design pilot program to address rehabs, assessments of existing buildings and HVAC operations and maintenance	Energy Commission	2007
Pass legislation that requires energy ratings and efficiency upgrades for properties participating in tax credit programs	Legislature	2007
Coordinate with state housing authorities and local low income housing organizations	Energy Commission /Strategy Development Group	2007
Identify areas with planned rehab projects and current buildings in need of upgrades and designate pilot program area	Energy Commission/Strategy Development Group	2007
Provide bill tracking software to prioritize efforts for housing authorities	Energy Commission	2007
Revise utility allowances to encourage efficiency	HUD/Energy Commission	2007
Launch educational and outreach efforts at the local level and work with authorities and owners to select projects	Energy Commission/ Strategy Development Group	2007-2008
Provide training and technical education and support to housing authorities	Energy Commission	2008
Provide audits	Energy Commission/Contractor	2008
Provide incentive programs for multi-family projects	IOUs	2009
Implement projects in pilot area	Energy Commission/Strategy Development Group	2008 - 2010
Evaluate program and modify to improve, continue or eliminate	Evaluation Firm	2008 - 2011

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Table 4-7
Residential Strategy Summary

Description and Annual Savings	Actions	Lead Role	Timeframe	Funding
Time of Sale Information Disclosure (175 to 186 GWh) Energy features of home disclosed to buyer Utility bills disclosed when authorized by seller Information booklet for buyers, brokers, appraisers on energy savings tips and services available Home Energy Rating System process concluded and utility incentives provided to reduce rating cost and offset measure cost Funding made available to train raters, brokers, appraisers and lenders on energy efficiency and energy efficient mortgages Voluntary participation followed by phased in mandatory program for pre 1982 homes, then all homes	Energy Commission concludes that energy features are material facts in the sale of homes Department of Real Estate, Energy Commission, real estate agents and others develop training curriculum on energy efficiency and energy efficient mortgages Department of Real Estate offers home energy rating instruction Energy Commission completes proceeding to adopt regulations establishing home energy rating system for existing homes Energy Commission develops brochure describing home energy rating system as required by law	Department of Real Estate, Energy Commission and real estate agents	2006 for information booklet, partner with realtors 2007 for HERS proceeding 2008 for revised booklet, training, and incentive development 2009 for pilot program to gain experience 2010 for phase I of mandatory program 2011 for fully mandatory program	Public Goods Charge funds Program cost: \$4 million annually to \$53 million, depending on phase
Information Gateway (62 to 259 GWh) Central information gateways established Customers receive feedback on energy use Online energy audits offer multilevel details Online audit provides referrals to energy services Advertising campaign	Utilities establish information gateway providing customers improved online audits and feedback on customers energy use Utilities include referrals for customers to act on Financing assistance offered to encourage customer action Flex Your Power promotes strategy through advertising campaign	IOUs and municipal utilities	2006 assess resources needed, evaluate online audit options and capabilities 2007 finalize program delivery 2008 – 2009 benchmark residential buildings, advertise and implement program	Public Goods Charge funds for IOUs Program cost: \$40 million annually
Whole Building Diagnostics (45 to 54 GWh) Contractor training on building diagnostic testing Incentives to help fund training and offset the cost of diagnostic services to customers Non-energy benefits considered in cost effectiveness determinations Advertising campaign	Utilities offer incentives for training and for customers choosing diagnostic services California Building Performance Contractors Association conducts additional training Energy Commission and CPUC establish methods to account for non-energy benefits Flex Your Power administers advertising campaign	Energy Commission, Public Utilities Commission, and utilities	2007 develop program, design incentives, and establish non-energy valuation method 2008 train contractors, advertise strategy and implement program	Public Goods Charge funds Program cost: \$12 million annually
Assistance to Affordable Housing (16 to 34 GWh) Technical services provided Housing authorities trained in energy efficiency (ratings and upgrades) Energy ratings and efficiency upgrades required for housing subsidized by tax credits	Utilities provide technical services to asset managers Housing authorities focus on upgrades during property rehabilitation, maintenance and at time of sale Administrators of tax credit programs ensure energy ratings performed	Utilities and housing agencies	2007 utilities offer technical assistance 2007 – 2008 property manager and housing agency training	Public Goods Charge funds Program cost: \$26.6 million annually
Equipment Tune Up (16 to 19 GWh) Air conditioners checked at time of property sale for proper operation Building standards are updated to include check of airflow in HVAC systems Utilities support certification of technicians Advertising campaign	Utilities, trade organizations, training organizations, and Energy Commission develop certification training for current and new HVAC professionals Energy Commission updates building standards, check and correction of airflow Flex Your Power conducts advertising campaign to promote certifications	Energy Commission, utilities and trade associations	2007 to begin certification training 2008 to update building standards 2009 to implement strategy	Public Goods Charge funds \$4.9 million annually

CHAPTER 5: Recommended Commercial Strategies

The Efficiency Committee considered several strategies for reducing peak load energy use in existing nonresidential buildings. Three strategies specific to nonresidential buildings were formulated by the Energy Commission's technical consultants, and two of these have been retained in this report. Table 5-1 displays the recommended strategies. Table 5-2 shows the estimated energy savings, cost, and cost effectiveness of each nonresidential strategy.

Data on existing building stock floor area, end-use intensity, saturation of equipment types within each building type and the energy savings potential of the technologies promoted by the intervention were taken primarily from the California Statewide Commercial Sector Energy Efficiency Potential Studies⁹, with additional secondary research conducted for this project by the consultant team. The overall commercial building stock was divided into segments representing two vintages (pre-Building Efficiency Standards and post-Building Efficiency Standards), ten commercial building types, the three electric IOUs (PG&E, SCE and SDG&E) and the three gas IOUs (PG&E, SCG and SDG&E). The building types defined for this study are offices, restaurants, retail, grocery, warehouse, school, college, hospital, lodging and other.

Commercial Benchmarking

The Governor's Green Building Initiative, Executive Order S-20-04, and its implementing Action Plan endorse benchmarking of all commercial and public buildings in California, calling on the Energy Commission to produce a plan, timetable and recommendations to accomplish this goal.

The benchmarking portion of the Order is a critical part of the Green Building Action Plan. There are two distinct tasks: 1) the mandatory benchmarking of thousands of state buildings, for which the Department of General Services is responsible, and 2) development of a statewide benchmarking system for voluntary use by the owners and managers of over 1 million private commercial buildings, for which the Energy Commission is responsible.

⁹ *California Statewide Commercial Sector Energy Efficiency Potential Study*, Prepared by Xenergy for PG&E, 2002; and the *California Statewide Commercial Sector Natural Gas Energy Efficiency Potential Study*, Prepared by Xenergy for PG&E, 2002. Both studies are available at www.calmac.org.

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Table 5-1
Nonresidential Strategy Summary

Description and Annual Savings	Actions	Lead Role	Timeframe	Funding
Retro Commissioning (152 to 182 GWh) Retro commissioning guidelines developed as identified in section 2.2.3 of Green Building Initiative action plan Develop infrastructure to provide services through additional training Incentives offered to increase demand for services Best candidate customers identified through benchmarking Promotional efforts to encourage property owners/managers to participate	Energy Commission develops guidelines and standards for commissioning private commercial and public buildings Utilities screen participants using benchmarking information and offer incentives to reduce cost of retro commissioning Energy Commission, utilities and California Commissioning Collaborative develop training materials and cost/benefit information to encourage greater use of retro commissioning Department of General Services, Energy Commission and Flex Your Power develop and distribute marketing messages to engage building owners	IOUs and municipal utilities, Energy Commission and Commissioning Collaborative	2006 utility incentive programs and commissioning guidelines developed 2007 training of providers 2008 program marketing	Public Goods Charge funds for IOUs Program cost: \$25 million annually
Commercial Building Benchmarking (26 to 33 GWh) Benchmarking tool developed All commercial buildings benchmarked and periodically rechecked Referrals to audit and retrofit improvement services provided Energy efficiency information provided to customers	Energy Commission completes benchmarking methodology (tool) as directed by Green Building Initiative Utilities develop program to benchmark all commercial buildings based on tool Legislature requires benchmarking when building financed or refinanced CPUC develops statewide program to promote benchmarking through Flex Your Power as specified in the Green Building Initiative Legislature requires CALSTRS and PERS to benchmark all buildings in their portfolio and pursue energy efficiency	CPUC, IOUs and municipal utilities, Legislature	2006 complete benchmarking methodology 2006 implement benchmarking	Public Goods Charge funds for IOUs Program cost: \$2 million annually

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Table 5-2

Nonresidential Annual Energy Savings Potential, Costs, and Cost-Effectiveness

Strategy	Gigawatt hours	Megawatts	Million therms	Program Cost (\$million)	Participant Benefit Cost Ratio	Total Resource Cost Benefit Cost Ratio
Benchmarking	26 - 33	6 - 7	0.5	2.0	2.51	1.05
Retro-commissioning	152 - 182	77 -92	8 -95	41.0	3.19	1.68
Total	178 - 215	83 - 99	8.5 - 9.5	43.0		

* Potential savings for demand response are high, but not quantified for this report.

The Green Building Action Plan directs the Energy Commission to perform the following tasks related to benchmarking:

- To propose a simple, California-specific energy efficiency benchmarking system for California's commercial buildings, with the input of other governmental agencies, public and private utilities and representatives of the business community.
- To provide the Governor with a plan, timetable and recommendations to accomplish benchmarking for all commercial and public buildings including benchmarking at the time-of-sale, and a system which discloses benchmarking ratings to tenants and buyers at the time-of-sale.

Benchmarking will allow building owners and managers to compare their building's energy efficiency performance in two ways: against the performance of similar buildings, and as a baseline to demonstrate changes in building performance over time. The tool alone will not reduce energy use: its purpose is to inform building managers about energy performance and to motivate them to make their buildings more energy efficient. It can also help establish investment priorities to take advantage of energy efficiency opportunities.

Prominent commercial building benchmarking systems include the United States Environmental Protection Agency's (EPA) Energy Star[®] and the Lawrence Berkeley National Laboratory's (LBNL) Cal Arch California Building Energy Reference Tool. Both systems use a web interface to compare the energy consumption data of a particular building to a database of consumption data for a large number of other existing similar buildings. The EPA tool uses the federal Commercial Building Energy Consumption Survey (CBECS) data, while Cal Arch uses data from the Commercial Building End Use Survey (CEUS) that is specific to California buildings. Both databases are updated periodically. A current survey is now being conducted with building data being available for use by Cal Arch in late 2006.

Benchmarking tools typically compare energy consumption per square foot of floor space for comparable classes of buildings or Standard Industrial Code (SIC)

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designations. To calculate a “first level” benchmark requires only information that should be readily available without requiring energy audits of the building. By considering more detailed information, more insightful comparisons can be drawn. Therefore, the benchmarking tool should be designed to have multiple levels of increasing detail to allow both the simplest benchmarking rating and potentially more meaningful comparisons.

The overall elements of the commercial building benchmarking strategy include:

- Encouragement of benchmarking at the time of financing and refinancing.

Financing and refinancing are appropriate opportunities to consider the operating costs of the building and ways to reduce them.

- Utility billing information that can be used for benchmarking.

Utilities would make available to building owners sufficient information to allow them to compare their building's energy use to that of other similar buildings. A mechanism would be provided for continuous updating of benchmarking scores with each utility billing cycle, or some other timeframe, to track the effectiveness/impact of changes in building operations or installation of energy efficiency features.

Benchmarking also provides a means for utilities to identify poorly performing buildings for purposes of offering energy audits and energy efficiency information.

- Referral to energy efficiency programs.

Benchmarking alone leads to limited energy savings. To motivate further investigation into what may be cost-effective for the individual building, referrals to appropriate energy audit programs and opportunities for financial assistance for making improvements would be made.

The Efficiency Committee received supportive comments regarding benchmarking at its public meeting. The estimated energy savings range from 26 to 33 GWh. The strategy was also determined to be cost effective.

The Efficiency Committee recommends that this strategy be implemented through the following actions:

- The Energy Commission's PIER program should continue working with the Lawrence Berkeley National Laboratory and the Oak Ridge National Laboratory to develop a California-specific benchmarking tool. In addition, discussions with the EPA should continue on possible use the Energy Star® brand with California-specific data. Until an improved California-specific system is available, the Efficiency Committee recommends that benchmarking be accomplished by using the existing version of Energy Star®.

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- Utilities should be required to make available, under appropriate confidentiality considerations, billing information that could be used to benchmark all commercial buildings. A mechanism should be provided for updating benchmarking scores periodically to track the effectiveness of changes in building operations or installation of energy efficiency features.
- Legislation should be considered to require benchmarking during financing and refinancing events. Buildings are financed/refinanced periodically throughout their lives. It is appropriate to consider the operating costs of the building and ways to reduce those operating costs during these events.
- The utilities should provide referrals to retro-commissioning and retrofit services for interested customers who have received benchmarking information on their property.
- Utilities should provide energy audits and retro-commissioning for poorly performing buildings.
- The Energy Commission should work with the Building Owners and Managers Association (BOMA), the International Facilities Management Association (IFMA), and the Real Estate Leadership Industry Council (RELIC) to get benchmarking listed as a best practice for building property management. Enlisting these powerful trade organizations would be very helpful in promoting benchmarking.

Table 5-3
Action Plan for Benchmarking

Activity	Lead Organization/Support Organizations	Timeframe
Form expert panel to guide program development and direction	Energy Commission/DOE/EPA/LBNL	2006
Work with trade organizations and building owners to promote benchmarking as best practice	Energy Commission/BOMA/IFMA/RELIC	2006
Utilities integrate benchmarking into existing energy efficiency programs	Utilities	2006
Require benchmarking of CALSTRS and PERS buildings	Legislature	2007
Target poorly performing buildings for audits and retro-commissioning services	Utilities/Energy Commission	2007
Design and Market program	Energy Commission/ Flex-Your-Power	2008
Require utilities to provide referrals for retro-commissioning services for interested customers	CPUC/ Energy Commission	2008
Implement automated benchmarking	Utilities	2008
Require benchmarking of all commercial buildings during financing and refinancing	Governor/Legislature	2009
Evaluate program and modify as needed	Evaluation Firm	2010

Retro-commissioning

Retro-commissioning is a process for detecting and diagnosing faults in building operations so that system corrections can be made. It is recognized as a cost-effective strategy, typically involving on-going activities for improvement. Retro-commissioning results in low cost upgrades to building operations and control strategies and replacement of failed components, as well as recommendations for larger capital improvements and equipment replacements.

Elements of the retro-commissioning strategy include:

- Development of case studies relevant to commercial buildings.

Current literature about building commissioning relies primarily on information from government and institutional buildings where the operating issues may be different than in commercial buildings. Therefore, there is a need to develop relevant case studies as guidance to commercial building owners and managers.

- Assurance that there are sufficient numbers of skilled technicians.

Developing infrastructure is an important requirement for any commissioning strategy. Few providers offer high level commissioning services. Developing the skills and expertise of commissioning service providers through training is key.

- Use of incentives and/or tax credits to stimulate demand for retro-commissioning.

Although the energy savings potential from commissioning is strong, the market demand for these services is weak. Financial incentives, potentially funded through the utilities' efficiency programs would stimulate market interest.

- Recognition of the risk management attributes of retro-commissioning.

Casting commissioning as a risk management tool, rather than strictly an energy savings tool may provide greater value to the commercial building owner and manager community. Retro-commissioning of buildings helps control risk from volatile energy costs, as well as loss of tenants due to comfort issues and risks of litigation stemming from indoor air quality problems.

The Efficiency Committee received several comments on this strategy including an ongoing concern that the retro-commissioning industry needs to expand and that continuing training is essential. Some utility experience with retro-commissioning indicated that the services can be difficult to sell even when offered at no cost and that owners can also be slow to have the commissioning agents' recommendations addressed.

The Green Building Action Plan requires retro-commissioning of all state buildings over 50,000 square feet with re-commissioning every five years. In addition, the CPUC is

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directed to fund a statewide campaign to inform building owners and operators about building commissioning and ensure that PGC-funded programs include building commissioning. The Energy Commission is directed to develop guidelines and standards for commissioning and that commissioning is incorporated into building standards. The California Public Employees Retirement System (PERS) and the State Teachers Retirement System (STRS) are directed to consider cutting energy use in the California real estate portfolio through retro-commissioning. Case studies on retro-commissioning that result from the Green Building Initiative would serve as valuable examples for government buildings and businesses as well.

The estimated energy savings from this strategy range from 152 to 182 GWh. It was determined to be clearly cost effective.

The Efficiency Committee recommends that this strategy be implemented through the following actions:

- The Energy Commission and the California Commissioning Collaborative should develop and make available case studies from the commercial building sector. The case studies should emphasize risk management benefits.
- Utilities should identify customers for retro-commissioning potential using benchmarking information.
- Utilities should direct energy efficiency program funds to reduce the cost of commissioning services.
- The Energy Commission, utilities and the California Commissioning Collaborative should develop materials for training building operators and commissioning agents to increase awareness and build service capacity in the commissioning industry.
- The Department of General Services and the Energy Commission should develop and distribute marketing messages encouraging building owners and managers to have their buildings audited, upgraded, and retro-commissioned.

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Table 5-4
Action Plan for Retro-commissioning

Activity	Lead Organization/Support Organizations	Timeframe
Form expert panel to guide program development and direction	Energy Commission/ utilities/Commissioning Collaborative	2006
Review evaluation and technical reports, conduct assessment and further refine potential savings	Energy Commission/utilities	2006
Conduct program market demand and participation analysis	Energy Commission/ utilities/Research Firm	2006
Provide incentive programs	Utilities	2006 ¹
Develop program design and funding requirements	Energy Commission	2007
Develop case study selection and location criteria	Energy Commission/ utilities/Commissioning Collaborative	2007
Develop case studies	Energy Commission/ utilities / Commissioning Collaborative	2007
Train commissioning service providers	Energy Commission/ utilities/ Commissioning Collaborative	2007
Target customers	Utilities	2007
Market program	Flex-Your-Power, Dept of General Services/ Energy Commission	2008 ²
Evaluate program and modify to improve, continue or eliminate	Evaluation Firm	2008 – 2010

¹ Retro-commissioning is likely to be a component of the 2006-2008 Investor-Owned Utilities program portfolio.

² Coordinate with roll out of benchmarking strategy

CHAPTER 6: Demand Response

In AB 549 the Legislature specifically sought strategies to reduce the peak load electricity use in existing buildings in California. This policy recognizes the higher costs associated with increased electrical use at the time of peak demands, particularly due to air conditioning usage. Although increases in peak demands can be addressed through the addition of new power plants and transmission upgrades, demand responsive action by customers to reduce their demand during peak times can forestall this need for infrastructure additions. Customers' peak loads can be managed in a number of ways:

- Utilities can install equipment to allow utility dispatchers to “interrupt” customers’ power for periods of time when needed.
- Customers can agree to “curtail” their power use or be “interrupted” when called upon by the utility. Typically, these types of rates apply to very large customers who can provide large load reductions on an emergency basis when system reliability is threatened. Because the cost of providing incentives to maintain customer participation is high, as is the cost to the customers of responding, these programs are not the preferred option for system load management.
- Customers can voluntarily respond to public appeals for reductions in electricity use.
- Customers’ overall energy use can be reduced through effective energy efficiency programs such as are being proposed in this report, which also affects peak demand.
- Customers can be provided with price signals that reflect the higher cost of delivering electricity during peak time periods.
- Customers can be provided with advanced meters, control equipment and information that can be used to help them reduce their peak loads.

These last two actions are in the process of being implemented by the investor-owned utilities in California. Proceedings are underway at the CPUC, with Energy Commission collaboration, to enable the IOUs to provide all customers with advanced meters that will, in addition to allowing time-differentiated rate designs, offer a wealth of information and communication possibilities. Concurrently, the CPUC is considering authorizing “critical peak pricing” tariffs under which participating customers would pay significantly higher prices for the few highest cost hours of the year. Extensive experimentation in California and elsewhere has shown that customers will respond to these price signals by reducing their electric usage during peak times.

Besides meters and tariffs, customers can use more information about their consumption patterns and how those patterns affect their bills. While the largest customers have decades of experience with time-varying rates and many larger

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businesses have at least a couple years experience, the smallest business and residential customers have little, if any, familiarity with how their usage patterns affect costs and how demand reduction strategies can be implemented without major disruption or inconvenience. Customers in all classes would benefit from extensive education about their usage and demand response strategies as well as assistance in implementing those strategies.

A demand response strategy for reducing peak load electricity use would include the following elements:

- “Advanced metering infrastructure” for all electric customers in California.
- “Critical peak pricing” tariffs available to all electric customers.
- An extensive education campaign on the relationship between time of electricity use and costs.
- Comprehensive technical assistance services to customers who choose to alter their consumption patterns and improve their equipment stock
- Requirements in the 2008 and subsequent building standards for cost-effective advanced metering and associated technologies.

The Efficiency Committee recommends the following:

- The Energy Commission and the utilities should educate consumers on the rationale for time dependent pricing and the options available to customers to respond to these rates and reduce their bills.
- The Energy Commission should continue to support efforts by the California Public Utilities Commission to shift large customers to a default critical peak pricing tariff.
- California energy policy should support the development and deployment of critical peak pricing rates for residential and small commercial energy customers and the option of a dynamic real-time pricing structure for large (greater than 200 kW) customers.
- The utilities and the Energy Commission should encourage the installation of enhanced automation technologies that automatically provide demand reductions in response to price signals.
- The Energy Commission should consider requiring demand response technologies through the building and appliance efficiency standards as a means to increase system reliability and reduce customers’ costs.

- The Energy Commission should develop case studies showing the use of demand response control systems that successfully reduce peak loads without negatively affecting occupant comfort and productivity.

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APPENDIX A: AB 549 Research Approach

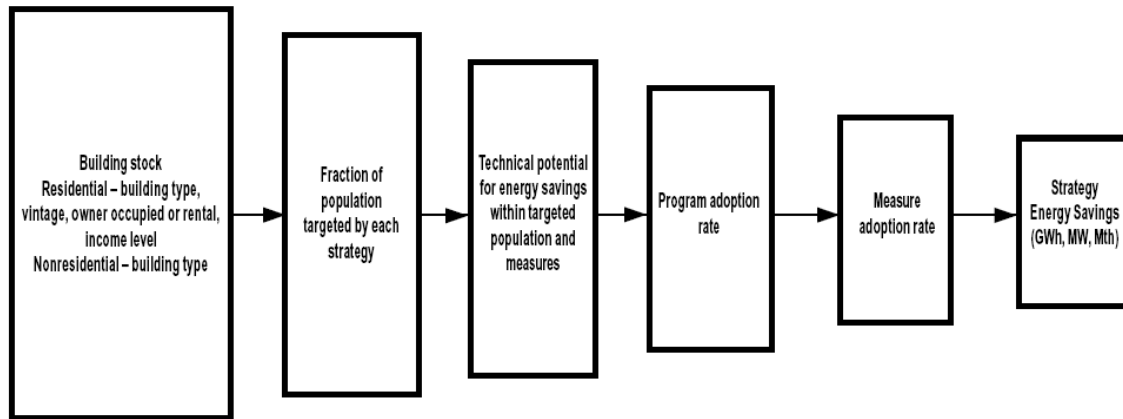
In compiling this report, the Energy Commission, through its technical consultants, conducted literature searches, program manager surveys, key participant interviews, and expert panel discussions; solicited public comment; and analyzed consumer-opinion survey and appliance saturation survey data. Market barriers to adopting energy efficient technologies were explored, as well as research into consumer behavior and other market participant motivations. The Energy Commission's Energy Efficiency Committee held two public workshops to gain input from stakeholders about possible strategies to improve the energy efficiency of buildings.¹⁰

From these discussions and research, 16 possible strategies were identified and ranked according to their potential for energy savings. The energy savings calculations were adapted from a model used by Energy Commission consultants, Xenergy, Inc., in 2002 for a series of studies conducted for existing residential and commercial buildings. The technical potential of a strategy (defined as the energy savings resulting from complete penetration of all measures in applications where they are deemed technically feasible) considered the existing building stock (segmented by vintage, income, ownership and/or building type), the fraction of building stock targeted by a particular strategy, the saturation of equipment types in each market segment that are candidates for upgrades, and the energy savings potential of the technologies promoted by the strategy. The strategy's energy savings were calculated from the technical potential, the program adoption rate, (defined as the fraction of the population targeted by the strategy that choose to participate) and the measure adoption rate (defined as the rate of acceptance of individual measures by program participants). This process is diagramed in Figure A-1.¹¹

¹⁰ To help guide this study, a Project Advisory Committee (PAC) was formed comprised of members of the California Measurement Advisory Council (CALMAC), which includes representatives from the investor owned utilities, the CPUC and the Energy Commission. The Project Advisory Committee provided guidance to the contractor, staff and the Committee and was involved in the review of products developed over the course of the effort. In addition, four public workshops were held to receive input as the report was being developed. Transcripts of workshops, presentations at workshops, and interim reports can be found on the AB 549 web page: www.energy.ca.gov/ab549/index.html

¹¹ Public Goods Charge (PGC) funds of \$300,000 were used for this portion of the AB 549 work as well as \$80,000 from the Energy Commission's Energy Resources Program Account. The technical support aspect of this project was led by Architectural Energy Corporation (AEC) under Contract Agreement No.: 400-04-001. Subcontractors assisting in this effort were TecMarket Works, Lutzenhiser Associates, RLW Analytics, Morton Blatt and the Davis Energy Group.

Figure A-1



For example, the low range of the “Information Gateway” strategy targets 10 percent of the pre-standards owner-occupied residential buildings. The technical potential of all technically feasible measures in the targeted population is 1,195 GWh, 686 MW and 145 million therms (MMth). An estimated 19 percent of the targeted population participates in the offering, and the participants adopt measures representing an average of 27 percent of the savings potential in each building. Under these conditions, the strategy is estimated to save 62 GWh, 18 MW and 6 MMth.

More detailed discussions of the approach used and the feedback received can be found in two supporting consultant reports:

- *Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings* (publication number CEC-400-2005-011-F)
- *Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings, Appendices* (publication number CEC-400-2005-011-F-AP)

The cost effectiveness analysis considered two broad measures. The first is participant cost effectiveness which includes energy cost savings, incentives paid to the customer and the customer’s out-of-pocket cost for the measure. Total Resource Cost (TRC) is the second indicator and includes the above costs as well as program administration and advertising costs. In addition, the net present value of the utility avoided costs over the life of the measures is calculated in determining TRC. The avoided cost calculations take into account the time-dependent nature of avoided costs, meaning that summer peak savings are valued more highly than off peak savings, and also consider generation, transmission, distribution and environmental costs.

Resulting benefit-to-cost ratios of greater than one indicate that the strategy is cost effective. The cost effectiveness analysis is useful in indicating relative cost effectiveness with the understanding that the benefit-to-cost ratios for one strategy could be higher or lower depending upon the assumptions used. Assumptions for each strategy are described in Chapter 5. Detailed assumptions for each strategy and measures within a strategy can be found in Appendix F of the consultant report.

The Efficiency Committee concludes that the strategies presented in this document will cost effectively save from 493 GWh to 767 GWh of electricity usage each year.

Of the 16 strategies formulated by the consultant team, eight are recommended for implementation. These eight are described in subsequent chapters.

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APPENDIX B: Strategy Assumptions

Time-of-Sale

Building Stock and Target Population

The residential time-of-sale strategy applies to owner-occupied single family homes and town homes of all vintages. The analysis focuses on owner-occupied homes only; investment properties are not included. According to the prior research conducted for the AB 549 project¹², single family homes and condominiums were sold in 2002 at the rate of 5.5 percent and 6.3 percent respectively. Assuming a total population of approximately 6 million owner-occupied single family homes and town homes, this represents approximately 332,000 resale transactions in these market sectors annually.

Program Adoption

The strategy is designed to be implemented in several phases, starting with a voluntary pilot program, followed by phase 1 mandatory disclosures of energy ratings for pre-Building Efficiency Standards homes, and phase 2 mandatory disclosures of energy ratings for all homes regardless of vintage. The program adoption rate for phase 2 was estimated at 85 to 90 percent of eligible participants, based largely on the expected enforcement level of the program.

Measure Adoption

Measure adoption rates for the strategy were taken from the evaluation, measurement and verification (EM&V) study of a voluntary time-of-sale program conducted in the PG&E service territory¹³, as shown in the Table B-2 below. Adoptions of energy efficiency measures by homeowners receiving energy efficiency information at time-of-sale was aided by referrals to existing equipment rebate programs that offset first costs.

¹² *Events and Measures, An AB549 Project Interim Report*, prepared by the Heschong Mahone Group for Southern California Edison, HMG Project #0304, October 3, 2003.

¹³ *GeoPraxis Time-of-Sale (TOS) Home Inspection Program Evaluation*, prepared by Robert Mowris and Associates, 2004, available at www.calmac.org.

Table B-2
Disclosure at Time-of-Sale Measure Adoption Rates

Measure category	Measure description	Adoption rate
Building Shell	Low e window replacement	0.11
	Ceiling Insulation	0.33
	Wall Insulation	0.2
	Infiltration Reduction	0.73
HVAC	High efficiency central AC	0.46
	Programmable Thermostat	0.53
	HVAC Diagnostic Testing And Repair	0.46
	Duct Repair	0.44
	Condensing Furnace	0.44
	High efficiency room air conditioner	0.46
Lighting	CFLs	0.63
	Interior fluorescent lighting	0.39
Appliances	Energy Star® Refrigerator	0.31
	High efficiency freezer	0.31
	Energy Star® clothes washer	0.1
	Energy Star® dishwasher	0.25
Water Heating	High efficiency water heater	0.19
	Low flow showerhead	0.17
	Pipe wrap	0.64
	Faucet aerators	0.8

Based on these measure installation rates, the average energy savings per participant was estimated to be 620 kWh, 0.18 kW and 34 therms per year.

Total Savings

The total energy savings estimated for this strategy are summarized in Table B-3.

Table B-3
Disclosure at Time-of-Sale Energy Savings

Homes targeted	332,000
Program adoption rates (probable to high)	0.85 – 0.90
Number of participants	282,000 – 299,000
Savings per home	620 kWh/yr 0.18 kW 34 therm/yr
Gigawatt hours	175 – 186
Megawatts	52 – 55
Million therms	9 – 10

Information Gateway

Building Stock and Target Population

The information gateway strategy targets owner-occupied single family homes and multifamily homes built prior to the Building Efficiency Standards, representing approximately 4.2 million units. Based on discussions with the residential working group and the expert panel representing program implementers from the IOUs and other stakeholders, an annual target of 10 percent of the total eligible population was selected, representing approximately 418,000 units.

Program Adoption

The program adoption rate was estimated at about 20 percent of the targeted participants. In this strategy, seven different designs were considered with a variety of levels of aggressiveness of the design, the implementation characteristics, and the energy supply conditions. For this strategy, the program design focuses on distributing information to targeted utility customers, working with an aggressive set of resource acquisition support programs (such as the PGC programs for 2006-2008), and repetitive message generation via multiple contacts with customers. Using this approach, an additional 20 percent of the market was assumed to install one or more of the measures promoted by the program.

Measure Adoption

The analysis assumes measures adopted by homebuyers in the same frequency as those reported in the evaluation of the SCE Residential Audit program¹⁴. Based on the measure adoption rates observed in this program, approximately 58 percent of a selected set of HVAC measures, 63 percent of lighting measures, and 40 percent of water heater measures were assumed to be adopted by participants. The measures selected and their respective adoption rates are shown in Table B-4 below.

¹⁴ See *Evaluation of the SCE 2002 Residential Audit Program*, prepared by Ridge Associates, 2004, available at www.calmac.org.

Table B-4
Information Gateway Measure Adoption Rates

End-Use	Measures Included	Measure Adoption ratio
	Ceiling insulation Floor insulation Infiltration reduction Wall insulation	0.58
HVAC	High efficiency central air conditioner High efficiency room air conditioner Programmable thermostat HVAC diagnostic testing and repair Duct repair Condensing furnace	0.58
Lighting	CFLs, interior fluorescent lighting	0.63
Appliances	ENERGY STAR® refrigerator ENERGY STAR® freezer ENERGY STAR® clothes washer ENERGY STAR® dishwasher	0.40

Based on these measure installation rates, the average energy savings per participant is 774 kWh, 0.22 kW and 79 therms per year.

Total Savings

The total energy savings estimated for this intervention are summarized in the Table B-5 below.

Table B-5
Information Gateway Energy Savings

Homes targeted	418,000
Program adoption rates (probable to high)	0.19 – 0.80
Number of participants	79,500 – 335,000
Savings per home	770 kWh/yr 0.22 kW 79 therm/yr
Gigawatt hours	62 – 259
Megawatts	18 – 75
Million therms	6 – 27

Equipment Tune-Up

Building Stock and Target Population

This strategy examines mandatory tune-ups at time-of-sale and time of replacement. The analysis of residential equipment tune-up and O&M services calculated impacts of the strategy applied to all single family and multifamily homes built prior to the Building Efficiency Standards. Homes are targeted at time-of-sale and when equipment is replaced, with an assumed equipment life of 20 years. The combined trigger event frequency from resale and/or equipment replacement is 10.2 percent for single family and 11 percent for town homes, representing approximately 532,000 units. Central air conditioning saturations vary from 16 percent to 72 percent across the building, ownership and income strata considered in the analysis, for an average saturation of 36 percent. The residential efficiency potential study further assumes that 50 percent of the units have not been tuned-up¹⁵, giving a potential participation of 97,000 homes.

Program Adoption

The program adoption rate was estimated at 50 percent of the targeted participants; reflecting a 50 percent compliance rate with the mandatory measure. The strategy can be expected to attain a 50 to 60 percent penetration based on prior experience with Building Efficiency Standards relating to HVAC replacements applied to existing buildings.

Measure Adoption

The analysis assumes refrigerant charge, airflow and duct leakage repairs on all homes with central air conditioning systems and/or furnaces, assuming 50 percent of the homes have not already had a tune-up. The estimated energy savings across all building types and climate zones is 330 kWh, 0.42 kW and 74 therms per home.

Total savings

The estimated electricity, peak demand and natural gas impacts of the strategy are shown in Table B-6.

¹⁵ The “incomplete factor,” or the fraction of the market that has not installed the measure estimated from is the residential potential study is 0.50 for the air conditioning tune-up measure.

Table B-6
Residential Equipment Tune-up Energy Savings

Resale or replacement events	532,000
Homes requiring a tune-up	97,000
Program adoption rates (probable to high)	0.50 – 0.60
Number of participants	49,000 – 58,000
Savings per home	328 kWh/yr 0.42 kW 74 therm/yr
Gigawatt hours	16 – 19
Megawatts	21 – 25
Million therms	3.6 – 4.3

Whole Building Diagnostic Testing

Building Stock and Target Population

This strategy considers whole building diagnostic testing of owner-occupied single family and multifamily homes with central air conditioning built prior to the Building Efficiency Standards. A voluntary program without any particular trigger event was analyzed. Approximately 7 percent of single family owner-occupied homes in warmer climates are targeted per year, representing 270,000 units.

Program Adoption

The program adoption rate was estimated at 10 percent of the targeted participants. The participation estimate ranged from a low of 2 percent to a high of 12 percent depending on the strategy's design and implementation approach. This strategy was not considered to be a high-demand initiative since it requires substantial education and marketing efforts to gain additional market share. The market is largely unaware of this efficiency strategy or the range of potential benefits from the service. Added penetration rates of about 2 to 5 percent were assumed based on only general information and promotional efforts, to as high as 12 percent of the market with general market-sector-level promotion and educational efforts, linked with targeted promotion to high potential customers, offering one-step service delivery. A 10 percent increase in penetration was assumed as a likely result of a more aggressive strategy linked to incentives.

Measure Adoption

Based on research conducted by Lawrence Berkeley National Laboratory, electricity savings for the whole building diagnostic service are estimated at 50 percent of the cooling electricity consumption, and 20 percent of the annual gas consumption for heating¹⁶. The average energy savings per home in the targeted climate regions are estimated to be 1,650 kWh, 1.5 kW and 68 therms.

¹⁶ See *Potential Benefits of Commissioning California Homes*, LBNL-48258, Lawrence Berkeley National Laboratory, Berkeley, California, 2002.

Total savings

The participation, electricity, peak demand and natural gas impacts of the strategy are summarized in Table B-7.

Table B-7
Whole Building Diagnostic Testing Energy Savings

Homes targeted	272,000
Program adoption rates (probable to high)	0.10 – 0.12
Number of participants	27,000 – 33,000
Savings per home	1,650 kWh/yr 1.5 kW 68 therm/yr
Gigawatt hours	45 – 54
Megawatts	40 – 48
Million therms	1.9 – 2.2

Assistance to Affordable Housing

Building Stock and Target Population

This strategy considers the impact of annual HVAC tune-ups of affordable multifamily housing units combined with comprehensive shell and HVAC upgrades of units undergoing major renovations. Based on housing stock data from the residential potential study and income distributions from the RASS analysis, the number of multifamily units is estimated at approximately 700,000 units. The analysis calculates the impacts of tune-ups applied to units with central air conditioning systems and comprehensive retrofits to all renovated buildings regardless of HVAC system type. Buildings built prior to implementation of Building Efficiency Standards are considered. Rehabilitation events are assumed to occur every 20 years, giving an effective rate of comprehensive rehabilitation of 5 percent per year. Considering the saturation of central air conditioning in multifamily units and the number of expected rehabilitations per year, a potential participation of 142,000 units per year was assumed.

Program Adoption

The program adoption rate was estimated at 43 percent of the targeted participants. The penetration projections ranged from a low of 5 percent of the market to nearly the entire market, depending on the design and implementation approach used. It was assumed that a general information program can be successful at capturing about 5 percent of the affordable housing market if structured to gain attention at key decision points. This level is because of the cost barriers for energy efficiency and the split-incentive issues associated with the benefits. Administration complexities and entrenched operational approaches characterizing this market constrain interest and participation in programs that promote energy efficiency. However, interviewees suggested that if the strategy includes the following features, that as much as 90 percent participation could occur:

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- uses aggressive, time-sensitive, and one-on-one promotional efforts
- links the above to targeted and participant-flexible program services that make the changes cost neutral
- incorporates state and federal support, and
- includes strong participant encouragement

An average increased penetration of about 43 percent was assumed.

Measure Adoption

The analysis assumes comprehensive upgrades to building shell and HVAC systems during rehabilitation, and annual AC tune-ups for all units with central air conditioning. Comprehensive rehabilitation projects are assumed to install high efficiency air conditioners and furnaces, low-e-glazing, added attic and wall insulation, air leakage sealing, and high efficiency water heaters or water heating boilers. Average annual savings per unit are estimated to be 269 kWh, 0.44 kW and 39 therms.

Total savings

The estimated participation, electricity, peak demand and natural gas impacts of the strategy are summarized in Table B-8 below.

Table B-8
Assistance to Affordable Housing Energy Savings

Homes targeted	142,000
Program adoption rates (probable to high)	0.43 – 0.90
Number of participants	61,000 – 128,000
Savings per home	269 kWh/yr 0.44 kW 39 therm/yr
Gigawatt hours	16 – 34
Megawatts	27 – 56
Million therms	2 – 5

Commercial Building Benchmarking

Building Stock and Target Population

The benchmarking analysis calculated impacts of the strategy applied to commercial buildings built prior to the Building Efficiency Standards, representing approximately 5 billion square feet of floor space. The analysis assumes that 20 percent of the total population is targeted, based on a mandatory benchmarking requirement during building refinancing, and a refinancing interval of 5 years, for a total potential participation of 1 billion square feet.

Program Adoption

Of the 20 percent of the buildings targeted, 20 percent elected to have energy audits conducted as a component of the benchmarking service. The estimates for increased penetration of benchmarking derived savings ranged from a low of 3 percent to a high of 29 percent depending on the strategy design and implementation approach. If the strategy provides only general distribution and limited targeted information efforts, the expected penetration level is placed in the 3 percent to 8 percent range. A 25 percent penetration rate is estimated if the strategy includes the following:

- an aggressive educational effort
- linkage to monthly on-bill benchmarking
- one-on-one out-reach promotional efforts, and
- participation and installation incentives

Measure Adoption

The analysis assumes that measures are adopted by commercial building owners in the same frequency as was observed through the evaluation of Statewide Commercial Audit program operated by the IOUs¹⁷. Unlike residential buildings, where audits triggered measure adoption rates on the order of 50 percent, commercial building audits are typically less effective at increasing measure adoptions. Typical measure adoption rates were 7.6 percent for lighting measures, 1.8 percent for lighting controls, 0.4 percent for exterior lighting, 1.8 percent for central HVAC plant measures such as high-efficiency chillers, VSD chilled water pumps and energy management systems, 4 percent for packaged HVAC system measures such as high efficiency rooftop units, HVAC system tune-ups and programmable thermostats, and 0.6 percent for motor measures and VSDs. Based on these measure adoption rates, the average savings across all building types and climates are estimated at 0.13 kWh/square foot, 0.03 W/square foot and 0.002 therms/square foot.

Total savings

The estimated electricity, peak demand and natural gas impacts of the strategies are shown in Table B-9.

¹⁷ Measure adoption rates were derived from the *Evaluation of the Statewide Commercial Audit Program*, conducted by....

Table B-9
Commercial Building Benchmarking Energy Savings

Targeted floor area	1,000 million square feet
Program adoption rates (probable to high)	0.20 – 0.25
Participating floor area	200 – 250 million square feet
Average savings per square foot	0.13 kWh/square foot 0.03 W/square foot 0.002 therm/square foot
Gigawatt hours	26 - 33
Megawatts	6 - 7
Million therms	0.5

Retro-Commissioning

Building Stock and Target Population

The retro-commissioning analysis calculated impacts of the strategy applied to commercial buildings built prior to the Building Efficiency Standards, representing approximately 5 billion square feet of floor space. The analysis assumes that 10 percent of the total conditioned floor space per year is targeted, representing a total of 470 million square feet of floor space.

Program Adoption

Of the 10 percent of the buildings targeted, 25 percent of the owners elected to have their buildings retro-commissioned. The estimate of the added penetration for the retro-commissioning strategy ranges from a low of 3 percent to a high of 30 percent. The low range includes the development of an information program targeting potential key customers. The information would be designed to present the benefits of retro-commissioning to key decision makers. No incentives would be offered in the low estimate. The high penetration estimate assumes a range of design components including:

- targeted customer information and educational efforts
- linkages with real-building demonstrations and publicized case studies, and
- trade ally training and incentives to lower costs

A 25 percent penetration was assumed.

Measure Adoption

Average unit energy savings and retro-commissioning costs from several retro-commissioning programs offered during the 2004-2005 program cycle were used. The average energy savings from retro-commissioning are estimated to be 1.3 kWh/square foot and 0.065 therms/square foot¹⁸.

¹⁸ These data are conservative relative to national average savings of 1.7 kWh/SF, 0.065 therms/SF from a study conducted by Lawrence Berkeley National Laboratory. See *The Cost-effectiveness of Commercial-Buildings Commissioning. A Meta-Analysis of Energy and Non-Energy Impacts in Existing*

Total savings

The estimated participation, electricity, peak demand and natural gas impacts of the strategy are shown in Table B-10.

Table B-10
Retro-commissioning Energy Savings

Targeted floor area	470 million square feet
Program adoption rates (probable to high)	0.25 – 0.30
Participating floor area	117 – 140 million square feet
Average savings per square foot	1.3 kWh/square foot 0.7 W/square foot 0.065 therm/square foot
Gigawatt hours	152 - 182
Megawatts	77 - 92
Million therms	8 - 9